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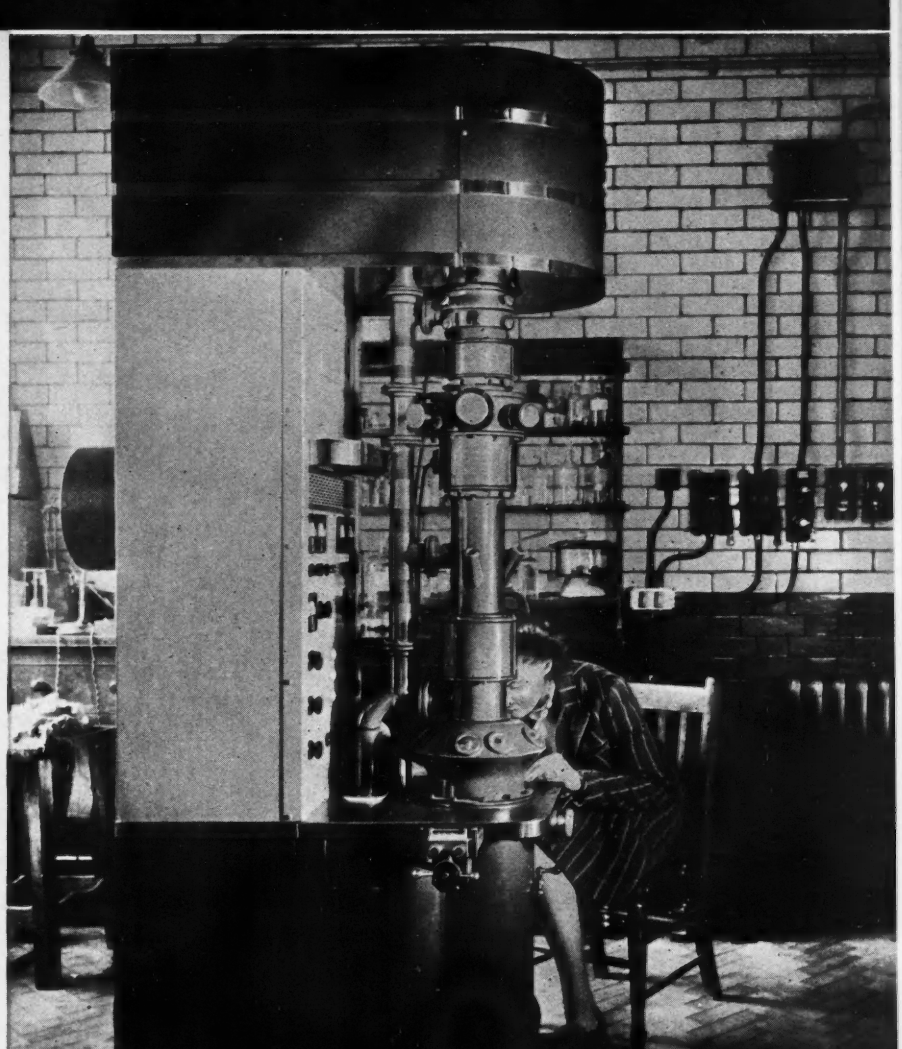

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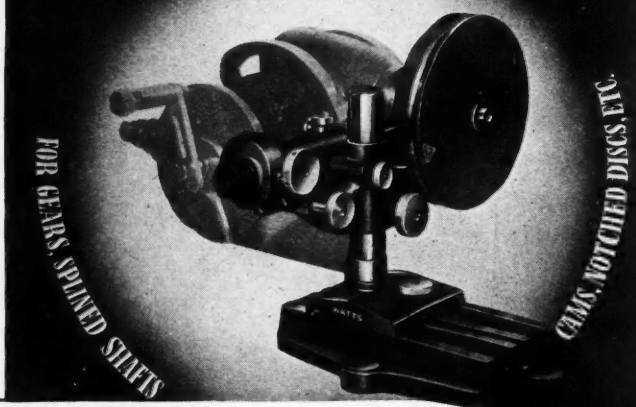

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October 1943 Vol. IV No. 10 PUBLISHED AT THE EMPIRE PRESS, NORWICH, ENGLAND Tel. 21441

The Progress of Science

A MONTHLY NOTEBOOK COMPILED UNDER THE DIRECTION OF DAVID S. EVANS

The Demobilisation of Scientists

THE optimists who felt that the surrender of Italy meant that all was over bar the shouting soon realised that there were still hard battles to be fought, and that no relaxation of effort could be excused. The war still has to be finished, and will not be finished without a heavy price of pain and misery even if the best possible strategy and the shrewdest direction are brought to bear. If the direction of the war should fall below this optimum level, the total price in American, Russian, Chinese, and British Empire lives will be correspondingly increased.

However, while an atmosphere of pessimism, as Mr. Churchill realises, seems to call forth our greatest efforts, at least we can feel that the ending of the war is not an event postponed to the Greek Kalends, but is something which may happen at worst within a few years, and at best within a not inconsiderable number of months. That will be an event which will be hailed not with mad enjoyment, but in a sober spirit of realisation that we can determine our future, and that that determination will call for the exercise of all our courage and native wit, if it is not to contain the seeds of a new disaster.

Britain entered the present war badly prepared, not so much in material munitions as in the mental realisation of what war would mean. Read the papers of 1939 and the spring of 1940: look at the editorials and the advertisements and ponder how much we have all learned at a bitter price. If we entered the war unprepared, if we sowed almost the full crop of disaster in the thirties, must we not think and plan now if the post-war world is not to be similarly afflicted?

To each section of the community some special problem seems of importance. The miners, the engineers, the builders, the farmers, the industrialists, and the scientists, whether in the Forces or out, are pondering the shape of things to come. Perhaps the scientists more than anyone have a broader field for thought, for theirs is a many-sided profession which they believe can, with advantage to every member of the community, be more fully employed for the promotion of the general welfare. Each side of our national activities can be considered in relation to the possible applications of science in it, but out of this collection of complex problems emerges one with which scientists have a special and personal concern.

That is the problem of the demobilisation of scientists. Applied to a profession which is probably the only one almost completely exempt from service in the ordinary armed Forces, the phrase sounds oddly. Nevertheless, the scientific profession in this country has been mobilised probably better—in spite of some glaring anomalies—than in any other of the United Nations, with the possible exception of the Soviet Union; certainly better than was possible in the emasculated culture of Nazi Germany. Scientists are accustomed to grumble at the defects of the Central Register, but it is clear that that body, although it lacks most of the powers that a properly organised "Scientific General Staff" ought to have, has performed an essential and vitally important function in keeping square pegs out of round holes. Its chief lack has been a drilling machine of its own. The training of new personnel in particular specialised branches of science, chiefly physics and radio, has proceeded apace, and the young men and women of Britain who have shown ability have been pushed rapidly through courses and sent to fill the gaps in the ever-growing scientific institutions of this country.

What is going to happen at the end of the war to the trained scientists who have been shifted out of their peace-time jobs, and to the incompletely trained new scientific workers who have been equipped in narrow specialities? It is certain that some of the peace-time jobs no longer exist; that the supply of new workers for some sciences has completely ceased; that most of the war factories and war research establishments will inevitably decrease in size; and that there will be an insufficient demand from peace-time organisations to permit wholesale transfer of certain types of scientists. On the other hand the war has enhanced the status of some sciences, and has even created new branches of science which could with advantage be developed for peace-time use.

The final fact that we must face is that many of the younger men and women are insufficiently trained for scientific work except in a single sector, and that they must, if they are determined that scientific work is their profession, be given full facilities for re-training or the completion of training.

This last factor is the one for which the remedy can most easily be suggested. It will be of the utmost importance for the half-trained scientists to go back to the Universities for the completion of their education. However, it will solve few problems if, for example, what appears by probable peace-time standards to be an over-staffed radio world finds all its junior staff replaced by an equal number of fully trained radio experts. Parallel with any scheme for the completion of training there should be a survey of needs, and an attempt made to divert trainees into fields, such as, for example, the training of teachers for the schools and the new technical colleges, where there is a crying need for personnel. For the Universities and their staffs such a procedure should enable them to effect a smooth transition from their present war-time character to their peace-time status, whatever that may be.

For demobilisation from industry the continuance of the Central Register, charged now with the survey of scientific needs and the allocation of personnel to meet them seems essential. The exact nature of the demobilisation process, and the time which it will occupy, will depend very much on the detailed circumstances in which the war ends, but, if possible, re-absorption of human resources should be coupled with re-allocation of the material means of production. The possibility of conversion of war factories to meet the peace-time needs of the areas in which they have been operating should be thoroughly investigated, partly to avoid wastage of existing equipment, and partly to avoid sudden discharge of a large volume of scientific labour which might be re-absorbed only very slowly.

One principle which it seems must be regarded as essential is that scientific labour should not be turned off without a job to go to. It may be an expensive business in the short run, but in the long run we shall find that if science is to be used to the full there will be a shortage and not a surplus of scientific labour.

A further outlet for trained scientists, also involving re-training, will be the better implementation of what may be termed the "cinderella" sciences, which although possessed of a vast potential have been neglected in the past. Compared with the work done in the U.S.A. and the U.S.S.R., our own development and application of geology and botany have been extremely poor. It may be objected that conditions are different here, and that for example our own country is too well-surveyed to need geological investigation and our agriculture too crystallised too make startling development possible. Nevertheless, it cannot be denied that by comparison with the immense services rendered to industry and agriculture in Russia by geologists and botanists the opportunities accorded to our own scientists make a poor showing. It is a vital need for our future that we should develop these resources, and that far greater amounts of money, and salaries to attract the greatest ability, should be provided for the optimum utilisation of the land on which we live and which grows much of our food. The fact is, that in spite of our vastly increased war-time agricultural output, we do not possess the essential information concerning watersheds, geological formation, soil constitution and structure, the possible applications of vernalisation or the agricultural applications of genetical research and so on, which would enable us to get the best out of our available national assets.

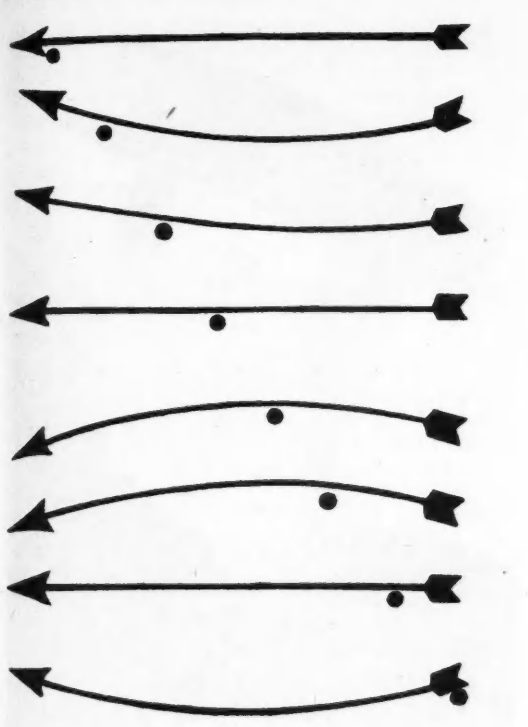
This brings us to the most essential point of all. If we decide on a Britain in which scientific research is an "extra" which can be dispensed with at pleasure, then we shall have too many scientists, and unemployment or a change of occupation is inevitable. In such a situation scientists would not be the only losers: the loss would be inflicted on the whole community. Demobilisation might then be successfully achieved, but it would be only the preliminary to a general recession in the scientific world. On the other hand, we can choose to implement our scientific resources to the full. In this case we should not have enough scientists. The same consideration applies in the medical world. There are too few doctors judged by the needs of the people, and too many for all to get a living if medical treatment is judged merely as a saleable commodity.

Perhaps the scientific profession might consider an invitation to Sir William Beveridge to resolve the antinomy, and certainly a definite official pronouncement on demobilisation and the post-war status of science would satisfy misgivings which are widespread among all grades of the profession.

The Archer's Paradox

ARCHERY, the beginnings of which are lost in the mists of history, now survives only as a means of warfare and hunting in savage communities and as a sport in civilised ones. History and legend are full of tales of prodigious accuracy of marksmanship, the most famous of which is the story of William Tell, and whose modern counterpart—so we are often assured on the screen—is the American sportsman who can shoot down mountain lions at a range of over 100 yards. Undoubtedly then, a good archer can hit his target. He draws the bow until the arrow head is back as far as the bow-stave, points the arrow at the quarry, making due allowance for the downward pull of gravity, and lets fly. The arrow speeds through space and lands quivering in the target. The whole process is a miracle of skill, and the accuracy is probably as good as that which can be obtained with a modern 'short-range weapon such as a Sten gun.

The surprising thing is that a superficial scientific analysis of the action of the bow shows that the arrow simply cannot be projected in the direction in which it is aimed, and has no business whatever to hit the target. The figure at the foot of the opposite page shows the arrow in two positions during its release. A is the bow-stave, and B shows the position of the string (marked by a black dot) when the bow is fully extended. The barb of the arrow is then in position 1, the arrow running from the string to one side of the stave, and pointing at the target. When the string is released it moves from 1 to 2 carrying the tail of the arrow with it, so that at the moment when the arrow leaves the bow at position 2, it no longer points at the target but is turned outwards through an angle which may amount to five degrees or more. This position is represented by the dotted arrow.



How then, does the arrow ever hit the target? The answer to this, the famous "archer's paradox", has been provided by the work of Dr. Klopsteg of Chicago, who studied the action of a bow during its release by means of high-speed flash photography.

The answer to the puzzle is that when the string is released it exerts such a great force on the arrow that the latter is set into vibration and buckles to a very considerable extent. The sequence of events as the arrow leaves the bow is shown in the figure above. The arrow in fact never touches the bow stave again as it is being released, but "snakes" its way round the stave and moves in the direction in which it was originally aimed. The process is in some ways similar to that by which a pole-vaulter projects himself over the bar. The skilful athlete always assumes just the correct posture at each moment of his flight, so that although he himself passes above the bar his centre of gravity passes underneath.

In just the same way the vibrations of the arrow must be of exactly the correct amplitude and frequency so as to allow the arrow's centre to move along a line which would be geometrically impossible if the arrow remained perfectly rigid. This last fact provides the explanation of a point well-known to archers, namely, that the bow and the arrow must be perfectly matched if accuracy is to be achieved. For each weight and strength of bow there is an arrow of exactly the correct weight and rigidity which must be used if perfect shooting is to be attained.

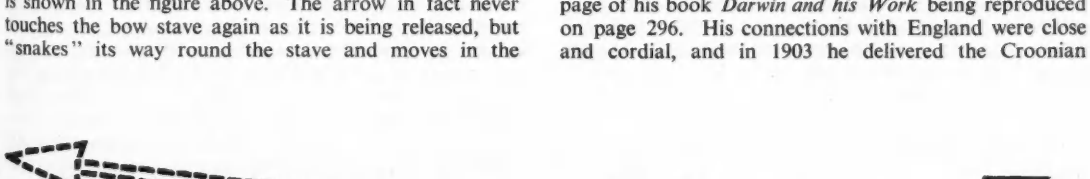
A Famous Russian Scientist

THE spectacular achievements of Russian science since the Revolution sometimes give the superficial impression that before the Revolution science in Russia was completely non-existent. It is true that it was at an extremely low ebb, and was confined almost exclusively to the repetition in teaching laboratories of experiments described by foreign scientists, but there are a few distinguished names which break through the darkness, and bear witness to the vast resources of human intellect which remained unused.

One such name is that of Klimenty Arkadevich Timiryazev, the plant physiologist and botanist, who was born just a century ago, and whose commemorative celebrations have recently been held.

An account of these recently printed in *Nature* describes the main outlines of his work, which was to a large extent concerned with the study of photosynthesis under the influence of radiation from various regions of the spectrum. Indeed his first work was on a spectroscopic study of chlorophyll, and he devoted much attention to the pigments involved in photosynthesis. His chief work was a volume on Plant Life, which was translated into English, and there is in existence a letter from Sir William Crookes acknowledging the receipt of a copy.

Timiryazev also earned distinction as a populariser of science, some of his articles being collected under the title of *Science and Democracy*. He was responsible for introducing the Darwinian theory into Russia, the title page of his book *Darwin and his Work* being reproduced on page 296. His connections with England were close and cordial, and in 1903 he delivered the Croonian



К. Тимирязев.

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II

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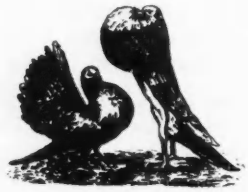

ИЗДАНИЕ СЕДЬМОЕ,
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В ДВУХ ЧАСТЯХ.

Часть I.

Lecture at the Royal Society, becoming a Foreign Member eight years later. He was awarded honorary doctorates at several universities including that of Cambridge. Our photograph shows him in the robes appropriate to that degree, and his statue in Moscow depicts him in the same garb.

He was a warm supporter of the Revolution and was elected a member of the Moscow Soviet by the railway workers, thus taking part in the government of the city where he had lived and worked for over thirty years.

He continued his work until a week before his death in 1920 at the age of 77. His name is not only a valuable link between ourselves and his native land, but he is acknowledged by Russians themselves as one of the outstanding figures of his time and the inspirer of much of the first rate agricultural botany which has been one of the greatest achievements of science in the Soviet Union.

Singing Kettles and Ocean Greyhounds

As tea-time approaches the singing of the kettle gives warning that the national afternoon rite of brewing the cup that cheers (but does not inebriate) must soon be undertaken. Perhaps it was mere curiosity, or the inspiration of an idle moment, that led Osborne Reynolds to investigate this problem of applied science and to suggest an explanation for this familiar phenomena. His theory, published in 1894, explained the noise as due to the sudden collapse of hosts of steam bubbles. The bottom layer of water in the kettle begins to boil first, and small bubbles of steam rise from it into the cooler water above. The bubbles become supercooled and collapse suddenly, each collapse producing a slight click as the water enters the cavity. All the myriads of clicks produced by the collapsing bubbles together produce the almost musical note which cheers us by its promise of good things in store.

Exactly the same kind of phenomenon occurs whenever the pressure in water is reduced below the vapour pressure at the given temperature. When this happens small vapour bubbles will be produced, which will collapse if they suddenly pass into a region of higher pressure. This happens for instance when water flows down a tube and reaches a constriction. As the water passes into the constriction its speed of flow increases, because a constant amount of water has to get through a narrower tube. The well-known theorem named after Bernoulli then predicts that the pressure should fall. If this fall is great enough bubbles will be formed, which will be annihilated as the water passes out of the constriction into the high pressure region again.

The ocean greyhound comes into this story almost as soon as fast steam navigation became a possibility. With the growth of fast overseas communication and the commercial advantages and national prestige that accompanied the possession of such honours as the "Blue Ribband of the Atlantic", ocean-going liners became ever bigger and faster. It was then that a peculiar

form of damage to ship propellers first began to be a serious problem. Even the utmost care in the casting of the propellers and the selection of materials for their construction did not protect them. It was found that, sometimes after only a few hours running, the propeller blades had become pitted all over and were soon in danger of complete disintegration. Such a phenomenon was noticed in the propeller blades of the Mauretania and Lusitania in 1912, and the same sort of damage was found in high-speed hydroturbines and compressors. So serious did the problem become that in 1915 a Royal Commission was appointed to investigate the problem. The results, published between 1917 and 1919 showed that the damage was due, not to some form of chemical action of sea-water, but to a phenomenon essentially the same as that which produces the singing of the kettle, and which is known technically as "cavitation". It was suggested that each time a bubble collapsed it produced a blow of quite considerable force, which transmitted through the incompressible water, fell on the metal surface and in time by the cumulative effect of many such blows, produced roughening and pitting. In the case of the kettle the necessary pressure changes are produced by the stratification of the hot water. In the case of the propeller the changes produced as the blades revolve, producing high pressures and suction, are very much greater.

The first theoretical investigations were not very satisfactory, but in 1917 Rayleigh produced a fairly satisfactory theoretical treatment which suggested that a bubble collapsing at or near a surface, to a given fraction of its original size, could produce impulsive pressures which might be as large as 40,000 atmospheres. There are various reasons for thinking that these values must be upper limits, and that the actual values are less, but this theory was important because it gave some indication of the great power of this effect, and provided some theoretical basis for further work. Some experimental work was done in 1932, but recently two Russian workers, Kornfeld and Suvorov, have made a very careful experimental study of the problem which has thrown considerable light on the subject.

They took a nickel tube which was made to vibrate along its length by means of a coil carrying a rapidly oscillating current wound round one end. Into the upper end was screwed the flat specimen, usually an aluminium disc, which was to be investigated. The tube with its specimen was then placed vertically in a specially constructed water-bath and set into vibration. As the top of the tube moved up and down in the water at over 7000 times per second producing large and rapid oscillations of pressure, a variety of phenomena was observed.

If the stroke was small, say, only 0·005 millimetres, a few slow-moving, tiny bubbles were seen, and occasionally a "dancing" milky white bubble which moved rapidly and erratically about on the surface of the specimen. If the amplitude was increased to 0·01 millimetres, a mass of bubbles, forming a starfish-shaped cloud, became visible. All these were milky in colour and in rapid motion, and the cloud rapidly destroyed the surface of the aluminium, roughening it perceptibly in about half-an-hour. A still greater oscillation, up to one-fiftieth of a millimetre in amplitude, produced a single large bubble at the centre with a diameter of one or two millimetres, which gave out a distinct hissing noise, and which chewed a hole half a millimetre deep in the aluminium in half a minute.

It appears that these milky "dancing" bubbles are those responsible for the destruction, and experiment showed that they could bore their way right through a sheet of thin aluminium foil. By varying the chemical composition of the liquid used it was also possible to show that the destructive effect had nothing to do with the chemical nature of the liquid, but must in some way be due to the physical action of the bubbles. However, at this point a difficulty arose. Rayleigh had thought of the bubbles as collapsing completely and producing their effects by the sudden inrush of water, but high-speed photography of the bubble clouds showed that this did not happen to any appreciable extent, and could not account for a pressure of more than twenty or thirty atmospheres, instead of the several thousand which was suggested by the magnitude of the destruction.

High-speed photography, however, showed something else as well. These dancing bubbles were not circular in section, but were little polygons with indented sides. This provided the clue to the mystery. The damage is done by the vibrations of the bubble. A stretched string can be set into vibration in various ways. It can move up and down all together, or one part can move upwards and another down, the centre of the string remaining stationary. In two dimensions a drum-head shows the same effect. Some parts of the drum move up and down, and are separated by lines which are not moving at all. Scatter some fine sand on a drum, and sound it. The sand will collect on these stationary lines and make them visible. The surface of a vibrating bubble does the same, the stationary lines being seen in section as the vertices of a polygon, the indented sides being the surface of the vibrating bubble "fixed" by the instantaneous flash of the high-speed photograph. It is these rapid vibrations and the pressure changes which they produce in the surrounding water which are responsible for the destructive effects of these bubbles, and which presumably do the same disservice for ship propellers.

The discussion concludes with some suggestions for a remedy for cavitation. One is that the propellers should be given a rubber coating, which would be not very much inferior to metal in resisting cavitational erosion, but which could easily be replaced. Another is that attention should be paid to reducing vibration of the propeller and to keeping the pressure at every point of the surface above the vapour pressure of the water.

If this story has a moral it must be that there are few places where the scientist cannot be of use, and that even these investigations directed to the most severely practical ends are likely to broaden our theoretical knowledge and give us new weapons of pure research.

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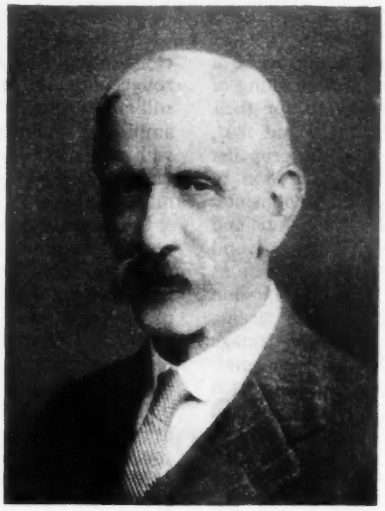

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Sir Frederick Gowland Hopkins, O.M., F.R.S.

PIONEER OF VITAMIN SCIENCE

WITH the war and the Ministry of Food advertisements the term " vitamin" has become fully digested into the common language, whereas "protein" and "carbohydrate" are still firmly rejected.

The importance of vitamins is now well recognised; vitamin concentrates have been made available at cheap rates to maintain the health of babies and expectant mothers; to improve night vision among flying crews basins of Vitamin A are passed along R.A.F. mess tables together with the condiments; in New York night clubs vitamin pills are sold by the cigarette girls, as an alleged cure for hang-overs. Synthetic vitamins are now an essential product of the pharmaceutical industry; in America, for instance, enough ascorbic acid tablets are made to prevent 30,000,000 people catching scurvy even though they touched no vegetables or fruit for a whole year. Yet it is only 31 years ago that Sir Frederick Gowland Hopkins—"Hoppy" to his friends—published the results of those classic experiments which established the existence in a natural food of an accessory food factor or factors.

In these tests he fed young rats on a "synthetic" diet containing nothing but purified casein, carbohydrates (starch and cane sugar), fat (lard) and mineral salts. To be precise, he kept one group of rats on this diet, while to a control group he fed the same food but with the addition of a minute ration of fresh milk—about half a teaspoonful. The rats that had no milk grew less rapidly than the others, then stopped growing altogether, began to lose weight and eventually died. After about twenty days on the deficient diet they would weigh little more than at the start of the experiment, but if at this stage they received a ration of milk they put on weight as rapidly as did the members of the other group.

I should have liked to give further details of this piece of work and the conclusions which Hopkins based upon it, but there is no room to do so here; I suggest that anyone who is interested should read the original paper in the *Journal of Physiology* (1912, 44, 425) or consult one of the books on vitamins by Leslie J. Harris. These experiments certainly helped to lay the foundations of the science of vitamins, so that the Germans have given Hopkins the title of *der geistige Vater der Vitaminlehre*—the spiritual father of vitamin science. I believe that Hopkins himself prefers to be known more simply as one of the founders of vitamin research.

Apprenticed to Chemistry

Sir Frederick has just retired from the Sir William Dunn professorship, after being associated with biochemical research at Cambridge for 45 years. Born in 1861, his career did not follow the normal continuity of school, university, graduation, research. It would probably have done so if his father, a man keenly interested in science and with a bent for natural history, had not died while Hopkins was still a lad. Had he lived it is likely that the son would have had every opportunity he could have wished for. As it was, after leaving school he spent some time at an insurance office before he was able to convince his uncle, who was his *de facto* guardian, that he had more enthusiasm for scientific work than for a career in the City of London. So at the age of seventeen, having won his point, he became apprenticed to a consulting chemist. The next three years of his life were to a large extent wasted, for during that important formative period he was not taught one word of theoretical chemistry. Realising his lack of fundamental knowledge he started to attend classes at South Kensington and University College, London, and these enabled him to qualify for his fellowship of the Institute of Chemistry. It was now that Dr. (afterwards Sir) Thomas Stevenson invited him to come

and work in his laboratory at Guy's Hospital. Stevenson was then an official analyst to the Home Office, and Hopkins's work as his assistant was concerned with the detection of poisons in murder and other criminal cases. Hopkins gave evidence at a number of famous trials, and that the work interested him is proved by the fact that when in later years he went to Cambridge he himself acted as a Home Office analyst for a short time.

He spent five years with Stevenson, and his investigations in the laboratory at Guy's Hospital aroused his curiosity about the physiology of the animal body. In those days there were few scientific studies which could be described as biochemical in the sense we use that term to-day; there was physiology on the one side, and chemistry on the other, and the fringes of the two subjects were only just beginning to meet and merge. Hopkins realised that if he were to undertake any explorations into the embryonic science represented by the coalescence of the two separate sciences of chemistry and physiology, he would need to know more about the functioning of the animal body. The outcome of this realisation was that in his twenty-seventh year Hopkins became a medical student at the school of Guy's Hospital. While qualifying for his M.B. (which he obtained in 1893) he continued to do a good deal of research, and in 1894 he received his D.Sc. for this research work. He had become a member of Guy's teaching staff, and everything seemed set for him to follow a medical career as a clinician, when, in 1898, Sir Michael Foster, professor of physiology at Cambridge, invited him to join his department for the purpose of establishing a curriculum of teaching in physiological chemistry. Thus began a Cambridge career which has lasted for 45 years.

To make it clear how Hopkins started his biochemical researches I will go back some few years. In his youth he had been an enthusiastic entomologist, collecting butterflies, moths and beetles; unlike most boys of his age he was however most interested in the way the insects lived and carried out their natural functions, being a naturalist rather than a collector. His first scientific publication—in the *Entomologist* of 1876—was concerned with the bombardier beetle. This insect, fairly common in certain parts of the south and south-east coasts of England, has the intriguing habit of releasing, when disturbed, a series of puffs of acrid violet vapour rather like a motor-cycle back-firing. It was this secretion that Hopkins tried to analyse, but the experiment was not a success.

Early Research Work

His first important researches were concerned with the yellow pigment found in the wings of the common cabbage-white butterfly; he was able to show that this pigment, now classed as a pterin, was a derivative of uric acid (*Phil. Trans.* 1895) and it is interesting to note that recently he returned to his early studies of the pterins. (*Proc. Roy. Soc.* (B) 1942, 130, 359.)

His next investigations were in the field of human physiology. While he was at Guy's Hospital it was a medical fashion to attribute many complaints to an excess of uric acid; a convenient method of estimating uric acid in urine was needed, and Hopkins was able to perfect a technique which soon came into general use. About this time he studied, with Dr. (afterwards Sir) Archibald Garrod, the pigments of urine. He next became interested in the proteins, a class of substances so complex that they have kept biochemists busy for the past half century and are likely to demand equally concentrated attention for the next 50 years. When he started, comparatively few proteins had been isolated as chemically pure substances, and he was able to add to this small number by isolating a crystalline egg albumen. Two years later, in 1901, he isolated, in collaboration with S. W. Cole, that important constituent of many proteins, the amino-acid known as tryptophane.

In 1905 he became a tutor of Emmanuel College, a post he held until 1910 when he was elected to a prælectorship of Trinity College which enabled him to devote all his attention to research into physiological chemistry. In 1905, too, he was elected a fellow of the Royal Society. Working with Fletcher (later the first secretary of the Medical Research Council) he studied the formation of lactic acid in muscle, and so laid the foundation of our knowledge of the chemical phenomena which accompany muscular contraction.

The year 1906 was an important one for Hopkins, as he resumed his investigations on proteins, and these led him to carry out feeding experiments on animals which proved how essential tryptophane was to growth. Arising from his early feeding experiments came the following historic prediction, made in a speech to the Society of Public Analysts in 1906.

> " . . . No animal can live upon a mixture of pure protein, fat and carbohydrate, and even when the necessary inorganic material is carefully supplied the animal still cannot flourish. The animal body is adjusted to live upon plant tissues or the tissues of other animals, and these contain countless substances other than the proteins, carbohydrates and fats. Physiological evolution, I believe, has made some of these well-nigh as essential as are the basal constituents of diet. The field is almost unexplored; only is it certain that there are many minor factors in all diets of which the body takes account. In diseases such as rickets, and particularly in scurvy, we have had for long years knowledge of a dietetic factor, but though we know how to benefit these conditions empirically, the real errors in the diet are to this day quite obscure . . . I can assert that later developments of the science of dietetics will deal with factors highly complex and at present unknown."

By 1912 he had given to this prediction an air of reality; I might almost say *finality*, in view of the conclusiveness of the experimental results which I sketched at the beginning of this article. It should not be thought that Hopkins had done no further feeding experiments between 1906 and 1912; in his paper published in the latter year he explains that the particular experiments he is describing were undertaken to put on a more qualitative basis the results he obtained as far back as 1906-7, results which were summarised in lectures delivered at Guy's Hospital in June 1909 and which were not published owing to his ill-health.

Cambridge School of Biochemistry

Hopkins's early vitamin researches were undoubtedly handicapped by lack of equipment for carrying out feeding experiments. For instance in the Cambridge physiology laboratories, there was no animal room which

could be heated in the winter, so that he had to keep his rats in the ordinary laboratory, later removing them to the disused coal cellars where according to the diet they received they would thrive or pine away in cages that were all mixed up with A. V. Hill's galvanometers. It was not until 1913 that the university started a separate biochemistry department, the professorship—the first of its kind in the whole world—going, of course, to Hopkins. His facilities for research were immeasurably improved in 1921, when the trustees of the Sir William Dunn estate decided to provide the funds for the foundation of a school of biochemistry, housed in a separate building which was opened in 1925. It is from the direction of that institution that Sir Frederick has just retired.

His later researches have been mainly concerned with the study of enzymes that control the oxidation and reduction processes in living tissues, a subject which seems to be closely related with the functions of at least some of the vitamins. In 1921 he isolated glutathione, a compound composed of three amino acids and found in most cells, in which it plays the part of an oxygen-carrier. The study of oxidation-reduction systems has occupied the attention of many other workers in his laboratories; and it is interesting that the isolation of one of the vitamins, Vitamin C, arose directly from such studies made by Szent Gyorgyi in Hungary.

The Cambridge school of biochemists founded by Hopkins is world famous; either as members of his classes or as research workers in his laboratory are to be counted such well-known names as Dr. Joseph Needham, Albert von Szent Gyorgyi, Professor John Mellanby, Sir Edward Mellanby, Professor J. R. Marrack and V. B. Wigglesworth. His work, which has influenced medicine and nutrition as deeply as it has biochemistry, has brought him many awards both British and foreign, such as the Royal and Copley medals of the Royal Society, and the Nobel Prize (which he shared in 1929 with Eijkman). From 1930 to 1935 he was president of the Royal Society, and he has aided the State as a member of both the Medical and Agricultural Research Council. He has also been a president of the British Association and of the Association of Scientific Workers. He was created a knight in 1925, and a member of that very select order, the Order of Merit, in 1935.

Of his public utterances at least two are worth quoting here. In a presidential address to the Royal Society in 1935 he said he felt the advice and assistance of the Royal Society was less sought after by the Government than it had been, or was sought only upon matters of relatively small importance. "On broad general questions which bring science into contact with the State the constitution and prestige of the Royal Society give it the right to be so consulted. I believe that such questions exist to-day and I ask whether the Society with its unique authority, while always prepared to advise, should not also be prepared on appropriate occasions to approach the Government on its own initiative and even at times to make its own appeal to the public conscience." It was only a few years after those remarks that the Royal Society had to follow this advice to the letter, with regard to the mobilisation of scientists for the war. His other comment which I wish to mention concerns vitamins, and was made in 1933. "Owing to the abundance of all kinds of advertisements," he said, "vitamins are discussed in the drawing room as well as in the dining-room and also, though, not so much, in the nursery while at present perhaps not enough in the kitchen." Twenty years before that he had expressed the hope that vitamin researchers would display due caution, in view of the many baseless theories, the fads and fancies, which had affected the subject of nutrition. The more sensible attitude towards diet that has arisen from the sheer necessities of this war should be some slight consolation to Sir Frederick, helping to make up for all those abuses of vitamin knowledge—the fads and the fancies—that have been perpetrated since their discovery. WILLIAM E. DICK.

A Blackberry without Thorns

MERTON Thornless blackberry which is being released to the public this month by the John Innes Horticultural Institution is something of a new departure in plant breeding. With each plant is provided a leaflet telling what it looks like, how it grows and is cultivated and, what is most remarkable, how it happened. Mr. M. B. Crane, who is in charge of the fruit breeding work of the Institution, produced it. His work began in 1912. His object was to turn a thornless but small-fruited sport of a wild English blackberry (with the learned name of *Rubus rusticanus inermis*) into a large-fruited plant that would be worth growing. When it was crossed with other blackberries the seedlings were entirely sterile. The reason for this was not discovered until 1927 when a cytological colleague, C. D. Darlington, found that the thornless blackberry had fewer chromosomes than the other species. Fortunately, at the same time, one seedling arose by chance which had twice as many chromosomes as it should have had from its thornless mother. In consequence it was entirely fertile and nearly twice as vigorous—with fruits an inch across. Thornlessness however was recessive and it was not until 1935 (in the fourth generation) that good thornless types were extracted from the derivatives. The best of these was Merton Thornless. The new plant is therefore an example, one of the first, of the application of combined cytological and genetic methods to plant breeding. Those who take it up will be able, with the account of its origin before them, to carry the breeding work further. They will be able to produce themselves the new thornless blackberries of the future.

Courtesy of South Metropolitan Gas Co.

FIG. 1.—Interior of a retort house.

The Gas Industry: yesterday and to-morrow

E. F. ARMSTRONG, D.Sc., F.R.S.

THREE names are associated with the beginnings of the gas industry. William Murdoch was undoubtedly the first to discover the great quantities of gas which the burning of coal afforded and the use of gas as a source of light. He lighted up his house and offices at Redruth with gas generated in an iron retort in the backyard in 1792.

Following him, Samuel Clegg became practically engaged in adapting gas for lighting, first to a cotton mill at Sowerby Bridge and then to many other places. He early perceived the necessity for some simple process of purifying the gas and succeeded in producing lime purifiers which remained in use for many years. In 1812 he earned fame by lighting the establishment of Mr. Ackermann in the Strand, and in the following year became engineer of the Chartered Gas Company. He had practically single handed to give a public service supply. He invented the gas governer and many other pieces of apparatus, and to him more than any other individual the business of gas-making is indebted for the variety and utility of his inventions.

Frederick Albert Winsor, a man of unbounded imagination and sanguine temperament, was the first to advocate publically the distribution of gas from a central source, and his efforts led to the formation of the Chartered Gas Light & Coke Co., which to-day supplies more than half London and is the largest in the world. There was a rapid development of gas companies, of which there were some 200 large and small in 1829. There was consequently ruinous competition, especially in London, where in 1865 there were still 13 companies.

The primary use of gas for more than a century was for lighting, and there was progressive development of the apparatus in which it was burned. The batswing and fishtail burners marked a notable advance, but real progress was not made until 1850 when the improved Argand burner, making use of an air regulator, was patented. Sugg, in 1859, nearly doubled the light given by the street lamps in London with his pressure controlling device or governor. Just about the centenary of gas lighting, in 1892, the incandescent mantle was just coming into prominence: it gave new vigour to gas lighting, which for the first time was being menaced by electricity. The new electric bulb appealed mainly to the well-to-do on account of the convenience of the switch.

The use of the mantle developed rapidly as it was step by step improved, particularly when it was found that with adequate pressure a Bunsen burner would function properly with its mouth directed downwards and that consequently the flame could be used to heat an inverted mantle of beehive shape suspended from lugs on the inverted flame. As showing the progress, the first primitive burners gave a light of 2 candles, the early Argands developed 4 candles, whilst the modern room light gives 30 times as much, viz.: 120 candles.

Street lighting is conveniently compared in terms of candle power per cubic foot of gas consumed per hour. In 1899 it was 2·5 using flat flame burners; the substitution of mantles in 1902 brought this up to 14; the replacement of these by inverted mantles in 1913 made the figure 19; whilst in 1936, including some miles of lighting with high

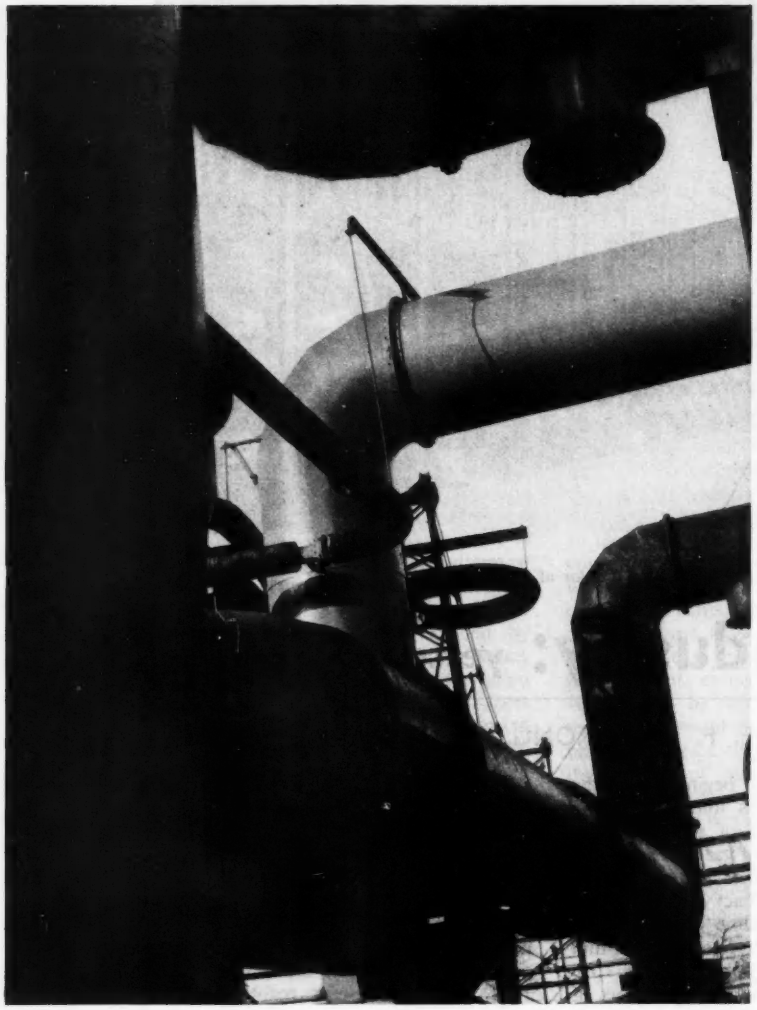

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FIG. 2.—Some of the huge steel pipes used to convey gas from process to process.

pressure lamps, it was brought up to 42·5. The figures apply to the whole area of the South Metropolitan Gas Co. and show the enormous progress made. The gas lamps in Whitehall before the days of the blackout gave an illumination of 2,500 candles in a direction at right angles to the surface to the mantle. It was probably one of the best lighted streets in the world.

Quality and Purity

During these years there was progress in the quality of gas and methods of purification, especially from sulphur compounds, which burn to sulphuric acid in the flame and in time act injuriously on the contents of a room. On the whole the gas engineer has been remiss on this point, and his failure has been one of the causes of the preference for electric lighting. It is only now that the question of sulphur removal is taken seriously; it should be regarded as essential to effect almost complete removal, which can be done at not too great a cost. This is one of the outstanding technical problems before the industry.

Town gas, after purification to conform with the existing statutory requirements, still contains small amounts of organic sulphur compounds. The Committee of the Institution of Gas Engineers, which studied this subject in 1942 (Institution Communication No. 250), recommends that as a first step the organic sulphur compounds should be reduced to 10 gr. per 100 cu. ft. by all gas undertakings without delay and that they should be encouraged to reduce it to 3 gr.

The use of gas as a fuel for heating and cooking was obvious, but its application had to wait because of the unwillingness of customers to purchase a costly appliance like a gas cooker of which they had no experience and some apprehension. It was not until the 1880's that the letting out of cookers on hire became general, whilst for the working classes it had further to wait until the development of prepayment meters. When early in 1892 the South Metropolitan Company introduced a system providing a meter and in many cases a cooking apparatus, no less than 43,000 installations were completed in 2 years, the system being rapidly adopted throughout the gas industry and so bringing gaseous fuel to the great majority of houses.

The future outlet for gas is for cooking and for the two other heat services in the home, namely space heating and for hot-water supply. The function of a house is to provide primarily protection from the elements and then the three heat services. In our damp climate we must be warm; we are beginning also to realise the benefit of a constant supply of hot water, a minimum of labour in getting it.

Great strides have been made in apparatus of all kinds, both gas and electrical, though solid fuel apparatus had lagged much behind perhaps, because its supply is in the hands of the speculative builder who had no incentive to spend money. The gas apparatus is too expensive for the householder to buy for himself—hence the development

of hire purchase which brings with it an obligation on the part of the user to take care of the apparatus. It is to be expected that post-war appliances will show distinct advantages over the types of to-day.

Gas has always been tested by the local authorities so as to protect the public. The standard was based on intrinsic illuminating power, but this ceased to be appropriate when the incandescent mantle as a source of light required heat for its operation and increasing quantities were used for heating purposes. There was a Board of Trade Enquiry in 1904, but it was not until 1920 that the change to a calorific value standard took place. By this the gas companies were allowed to choose whatever calorific value they deemed best —generally 500 B.Th.U. or less— and the method of charging for gas was altered so that the consumer paid not for so many cubic feet but for the number of therms of heat in the quantity supplied—a therm being 100,000 B.Th.U. To-day the illuminating power of gas burned in a batswing burner is low, but the householder gets a supply of a gas of standard constant calorific value at a constant pressure which burns regularly and efficiently on his apparatus. The question of the actual calorific power of a gas is one more for the companies than the consumer. There are some practical advantages in making a gas of lower calorific power, but then fewer therms can be sent through the service pipes, which if already burdened may be too small to give a proper supply.

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FIG. 3.—White-hot carbon being propelled through coke guides into the coke train.

By-Products

Coke is one of the most important products of the gas industry. In the early days when it was produced at low temperatures in iron retorts it was probably very similar in its combustion properties to the material widely known as coalite. Under modern practice with more complete removal of volatile matter from the coal, it has become less and less combustible and for a time was not very popular. More recently, particularly since the formation of a Coke Association in 1931, the question of the quality of coke had been energetically taken in hand, the moisture content is controlled, it is graded into standard sizes to suit the requirements of consumers, and by selection of coal the amount of ash in the coke is kept within bounds. After the war no restrictions on the choice of coals for carbonisation can be tolerated. To-day the public has been educated to use coke—both for water heating and, when burnt in grates of good design, for house heating— and the demand in winter is fully up to the available supply.

The avowed object of the gas industry is to get as much gas as possible out of a ton of coal: in consequence the temperature of carbonisation is always becoming higher whilst the coke becomes harder to burn except in special apparatus.

When carbonisation takes place at a lower temperature more volatile matter is left in the coke, which forms a smokeless solid fuel that can be burnt in an ordinary grate.

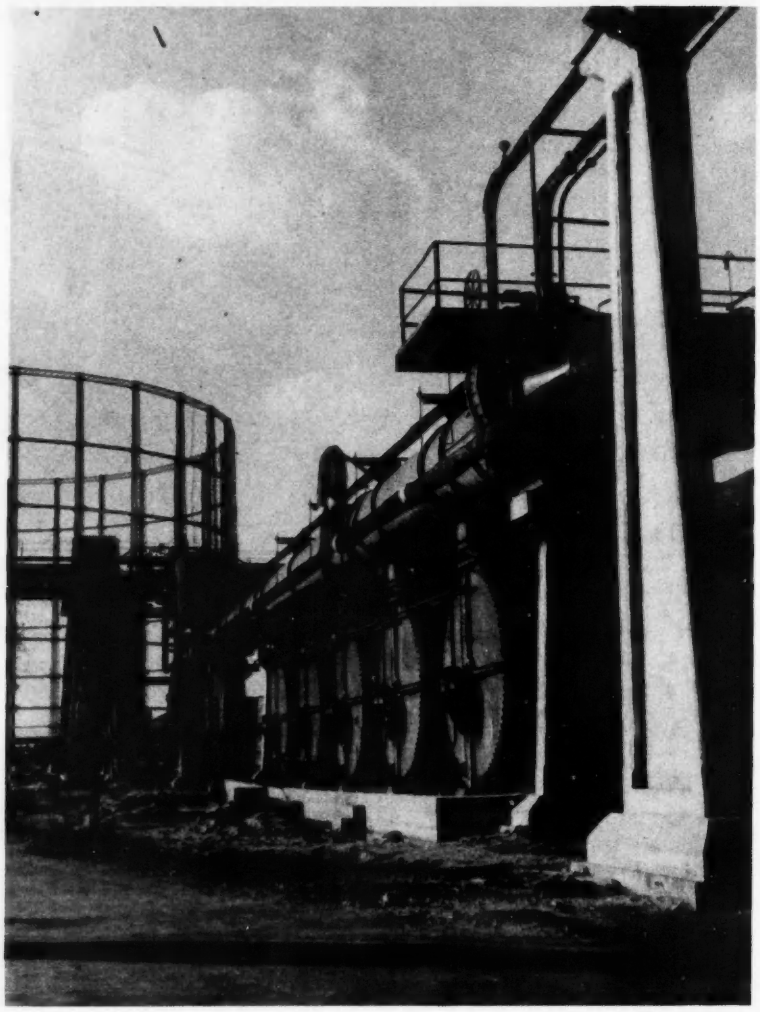

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FIG. 4.—The naphthalene washer in which the gas is washed to extract naphthalene.

Such low temperature fuel is made on a small scale and is deservedly popular with those who use it. There are many different processes for its manufacture, most of which have been unsuccessful commercially, largely for the reason that a solid fuel becomes the chief product in these processes whereas the gas industry makes its profit on gas and a book loss on its production of coke. The low temperature tar is different from high temperature tar, containing a higher proportion of gaseous olefines, which are more suited for hydrogenation to motor spirit.

A valuable secondary product of the gas industry is tar which is largely a complex mixture of aromatic hydrocarbons of, which benzole is the simplest. The discovery of the coal tar dyes made from benzole, which is first converted into aniline, naphthalene, anthracene, etc., brought fame to coal tar. Its constituents, which are separated by distillation, are the basis of that part of synthetic organic chemistry which is based on aromatic hydrocarbons. But the quantity required by the chemical industry is small compared with the total produced—some 2,000,000 tons a year, and the tar industry languished until the advent of the motor-car. Most of the benzole now goes as motor spirit: benzole is collected both from the tar and from the gas, since it is no longer required there as an illuminant. At the moment it is compulsory to extract it. This is done mainly by the oil-washing process, but there are other methods—the active carbon and the catalytic processes, which have the further attribute of ensuring lower sulphur content of the gas. The quantity of home produced motor spirit (benzole) is now considerable.

The other modern outlet for tar is on the roads to prevent dust: it has indeed made road transport practicable. Tar may also be regarded as a type of crude oil and available for cracking or other treatment to produce petrol. Considerable quantities of the creosote fraction are hydrogenated. Unfortunately for the tar industry, its cash value as a raw material for these purposes is inadequate. One cannot escape the feeling that full value is not being obtained for the unique aromatic hydrocarbons present in coal tar: there is opportunity on the part of the industry for research on a large scale, even though it may not bear fruit for a considerable time. It is a reproach to the industry when it cannot command more than crude oil prices for a product of this remarkable character.

Another product of the gas industry is ammonia, in which form the nitrogenous constituents of coal is obtained. It is recovered and sold as sulphate of ammonia to the farmers at a price which is regulated by the great synthetic ammonia industry. The profitable operation of ammonia recovery to-day requires the centralised working up of the ammoniacal liquor in plants where the process can be subjected to the closest control with the result that a product of high and reliable quality can be produced.

Large gas-works recover considerable quantities of sulphur, which are used for the manufacture of sulphuric acid to neutralise the ammonia. This sulphur replaces

the imported product, though the manufacture of the acid on a small scale would not be economical but for the saving in transport costs.

Cost

Gas is particularly a poor man's fuel, and any restriction on its use due to price definitely condemns him to a lower standard of living. There are nearly 11,000,000 domestic consumers of gas, of whom in pre-war days some three-fourths had a gross income of under £4 a week.

The use of raw coal is still large; out of the total domestic need for therms, gas supplied 20% and electricity 3% immediately prior to the war.

The comparative costs of coal, gas, and electricity per therm are misleading, since they take no account of the higher thermal efficiency of gaseous fuel or the far greater convenience in handling and labour-saving qualities of gas and electricity. The consumer can thus easily afford to pay a higher price per therm.

The cost of gas is one of the items regulating its consumption by the public: it is influenced mainly by the price of coal and also by wages and other factors. Whereas in the 1880's about 10,000 cu. ft. were obtained from a ton of coal costing 11/-, in 1935 the respective figures were 13,000 cu. ft. and £1 per ton. The average small house requires about 270 useful therms a year for comfortable heating. In the past the industry has supplied 20% to 25% of the total heat required by the domestic consumer by gas, and about 5% by coke. If, instead of supplying 60 or 70 therms per consumer per year, the industry supplied 250 to 300 therms, how mighty it would become!

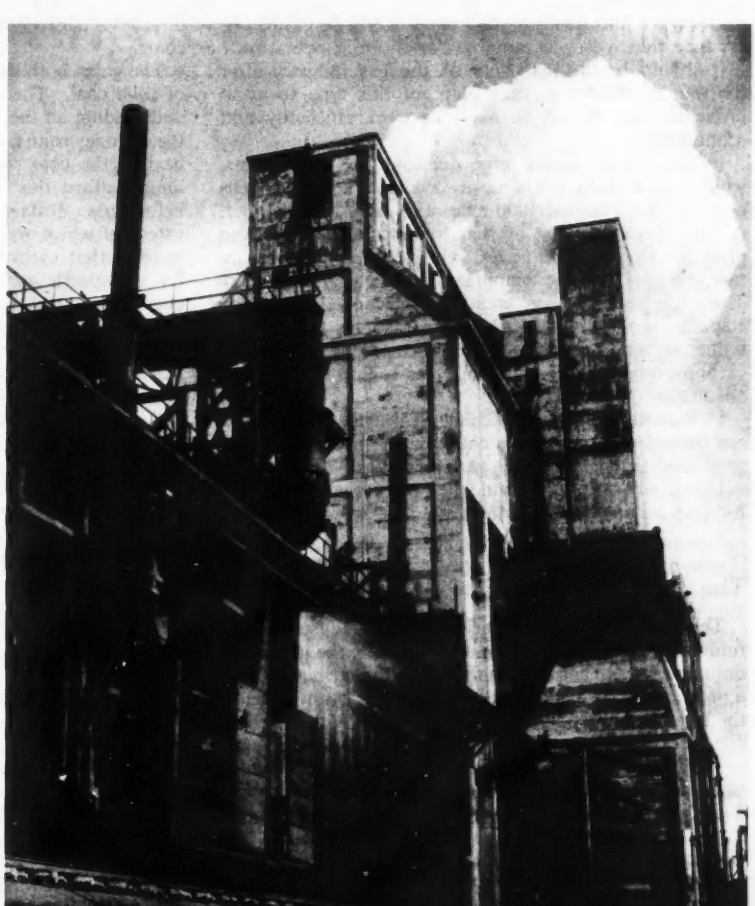

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FIG. 5.—The coke oven. In front of the oven door can be seen the oven door lifter and coke train.

New Processes

By far the most interesting are the processes of complete gasification. Existing examples of these are producer-gas and water-gas, but the gas made by either process is of low calorific value and the thermal efficiency is not very high. Moreover the gas contains a considerable proportion of poisonous carbon monoxide. Water-gas is largely manufactured for the purpose of meeting peak loads, it has to be enriched with costly gas oil.

The ideal constituent of gas is methane, which can be obtained by the direct hydrogenation of coal under pressure as it is undergoing decomposition. Research on processes to effect this have made considerable progress, and there is little doubt that a practical plant could be erected. The economics of the process turn however on the production of cheap hydrogen, which is not an easy task, though there are indications that it can be done.

According to Mr. E. V. Evans, "one pictures coal being charged into a vessel where it will be treated with hydrogen under pressure in such a manner that it will produce as much rich gas as is desired, together with a considerable quantity of a primary tar. Probably half the weight of coal will disappear in this operation. The other half will be fed to a producer operating under pressure and supplied

with oxygen and steam: in this vessel it will be gasified to produce the hydrogen required for the first operation."

It should be the first duty of the gas industry after the war to build a pioneer plant of this type so as to prove whether it can be made to work efficiently and economically.

In the United States large quantities of natural gas, which is essentially methane, are available at the oil wells and have been carried 1000 miles and more by pipe lines. A very large quantity of rich hydrocarbon gas is also available from the refineries, which serves *inter alia* as raw material for the manufacture of cheap hydrogen. This country is very greatly handicapped in many respects by the failure of the oil companies to establish refineries here: their gaseous products, so rich in hydrocarbons, might be tied into our gas industry with great advantage.

In industrial areas, particularly Sheffield, the surplus gas from the coke ovens is collected by means of a "gas grid" and distributed by the gas companies. This practice will no doubt become general when we reorganise the Fuel industry on more rational lines after the war.

The Future

The real problem confronting the gas industry in the future is to raise the consumption of gas by the individual domestic user so as to make the costs of distribution bear a proper relation to the holder costs of the gas and enable the price to be reduced. To speak plainly, if this is to be achieved the rival public utilities must co-operate instead of competing in the supply of electricity and gas, each supplying the public with its product in directions for which it is most fitted. This is no new thing in the United States, where one and the same company supplies both gas and electricity and goes so far as to decide which of them shall be supplied to the customer for a particular purpose. Both products are manufactured at a steady load and therefore more cheaply, the costs or waste of competitive selling is avoided.

Mr. E. V. Evans, in his presidential address to the Institution of Gas Engineers, has developed an argument which assumes the existence of a town of 200,000 inhabitants with the services normally developed and with prices as at present. It assumes that in three stages conditions alter in a normal manner leading to a result which may be summarized as follows: consumption of gas would increase fourfold, while average price per therm would fall from 10·4*d.* to 6·22*d.* Consumption of electricity would double and average price fall from 0·98*d.* to 0·7*d.* per unit. The fuel bill for the average domestic customer would fall from £17·9 to £16. Transport of solid fuel and ash through streets would fall to less than one fifth. The total amount of coal consumed for fuel and power would be reduced from 580,000 tons to 517,000 tons. Atmospheric pollution would be practically abolished, and the recovery of by-products—tar, benzole, sulphur, and ammonia—increased about fourfold. These gains require only the application of existing and technical knowledge, directed according to a national plan for the efficient use of coal.

The gains both to gas and electricity are at the expense of solid coal. The old-fashioned firegrate using raw coal and sending all the tar products and most of the heat up the chimney is an anachronism. Only 20% to 25% of the heat in the coal reaches the room. The nation can no longer afford this waste; all coal should be carbonised before use. Britain has no native oil—a handicap the extent of which we have yet to realise—and it should be insisted that every ounce of tar is recovered and used far as possible as the raw material for motor fuel and chemical industries. The coal industry must be forced to do likewise if we are to survive as a first-class nation. It is frightening, therefore, to find the Parliamentary and Scientific Committee in a survey of coal utilisation still largely advocating the burning of solid coal, though all will welcome the need for research on the scale with which the Committee advocates.

When it is remembered that the replacement of the coal-range by the gas-cooker has saved 15,000,000 tons of coal a year; that the consumption of coal per horse power of electricity has fallen since 1916 from 5 to 7 lb. to 1¼ lb.; that the thermal efficiency of gas-making is 80%—some knowledge will have been gained of the waste in giving an equivalent in raw coal.

The Select Committee on National Expenditure advise that as little raw coal as possible should be used for domestic purposes, and that when there is a choice gas should be used in preference to electricity. Not only because the relative quantity of coal required for gas production is less, but because its by-products are of value: there is none from electricity.

The gas industry consists of a large number of individual enterprises of all sizes from the very small to the very large. Many of these, though no doubt efficient in their way, are too small to satisfy the demands of an up-to-date industry. There is a growing tendency to form combines either covering most of the companies in a geographical area or isolated companies in different parts of the country. Such combines bring the advantages of central management, the best technical supervision, common buying and standardisation of stores, and may in time lead to large mergers covering a wide area. They may also include coke oven companies, much of whose gas is not at present used to the best advantage.

The prime duty of a gas undertaking is to give service to its customers: this involves gas of high and unvarying quality, satisfactory apparatus in which to burn it, which is both convenient, decorative and thermally efficient. —The housewife puts this factor last. Lastly, service in the form of regular visits from experts is desirable.

This is a chemical age—improved technique, a knowledge of catalysts, finer apparatus, are making new processes possible of which we hardly dream as yet. Complete gasification, a retort gas which is largely methane, the sale of the carbon dioxide as "dry ice" for refrigeration, the conversion of the off peak load into petrol, are all dreams of the future in which chemist and gas engineer may co-operate.

Recording Earthquakes

By E. W. POLLARD, B.Sc.

EARTHQUAKES occurred before the advent of Man on this planet. They are the growing (or dying) pains of an ever-changing globe. Ever since man has left records, these include some reference to the shaking of the earth. In biblical history we read that the earth shook and that the walls of Jericho fell down; Roman historians tell of quakes; but the richest records are in Chinese history. As with storms and pestilences, these quakings were regarded as supernatural, and various gods were blamed for them; or they formed a basis on which a new mystical religion was founded.

It is just about 100 years ago that a Frenchman, Perry, began carefully to list a number of earthquakes; during the next 50 years a scientific attempt was made to investigate their cause, mostly in Italy, because the origin was supposed to be volcanic and volcanoes were conveniently situated in Europe. But it was John Milne who, in the eighties of last century, made immense strides in the study of seismology, and he is commonly regarded as the "father" of the science. Milne was a character; when appointed in 1876 to the chair of Engineering of Tokyo University, he preferred walking across Asia to taking a P and O liner. In Tokyo he commenced the study of *near* quakes; he said he had them for breakfast, dinner, and tea. In 1895 he returned to England and set up an observatory for recording *distant* quakes in the suburbs of Newport in the Isle of Wight, and it was here that I had the honour of knowing him and his studio, as he called it; two of my friends continued to operate his instruments after his death in 1913 until they were transferred to the University of Oxford. Milne, with his Japanese wife, and assistant Hirota, were popular figures in the district.

An earthquake is one of the results of the natural and continual contraction of the Earth; just as a plum when dried to become a prune contracts and becomes corrugated, so does the earth buckle up on cooling. Quakes take place where the earth is changing more rapidly, in mountainous districts such as the Andes and Himalayas, and more especially where, as in the Western Pacific, the slope from the land to the bottom of the sea is very steep.

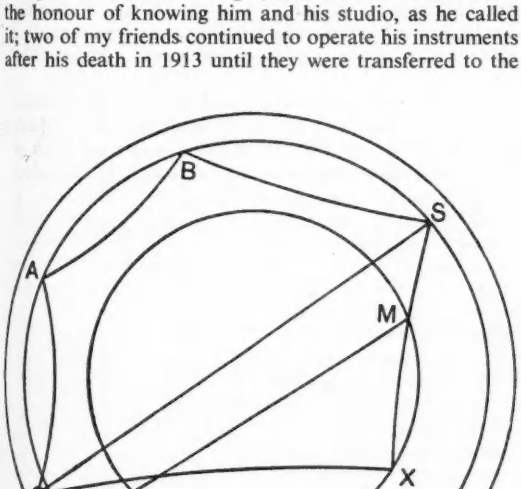


FIG. 1.

Origin of Earthquakes

Now let us consider figure 1, which represents the Earth. Starting from the outside we have the *crust* possibly in the neighbourhood of 50 miles deep, consisting of fully formed rocks; this merges into the *mantle* where rocks are in the process of formation. These two layers may be likened to the "slag" of an iron smelting furnace which comes to the top. The central *core* occupies about half the diameter; the material is under enormous pressure and may well consist of the magnetic metals, iron and nickel, in a plastic state.

An internal slip or movement may take place at a point S in the diagram; these points are usually not more than 30 miles below the surface though a few have been located at 500 miles. The slip may last but a few seconds, rarely minutes, but it causes a great disturbance and "waves" begin to radiate in all directions; on arrival at a distant station these waves may last for hours. The greatest effect is of course at a point on the surface of the earth immediately above the disturbance; this is called the *epicenter*. Waves are of several kinds, and like other waves may be reflected or refracted when passing from one medium to another; the reception of these varied waves forms the basis of modern seismology, and the study of the times of arrival at a distant station enables the scientist to locate the position of origin. The first type of waves, called *primary*, are condensational or push-pull, and travel fastest directly through the Earth or a sector of it and therefore reach a distant station before any others. The *secondary* are undulatory and travel more slowly. Both kinds suffer reflection and refraction when reaching the surface or the Core, and there are many paths from the origin to the station as indicated in the diagram. It is evident that different stations on the surface of the earth will receive waves at different times.

Besides the direct Primary and Secondary waves other waves are formed by the great disturbances at the Epicenter and these travel along the *surface* of the globe; these are slow waves with a long "period", a term to be explained later; they are the last to arrive.

Recording Instruments

Nearly all recording instruments depend on the principle of the Horizontal Pendulum—a piece of apparatus

rarely described in books on physics. Anyone interested in this article should perform the following simple experiment. Take a light rod, such as a cane, and into one end push a needle; at a point about a third of the way along from the needle, tie on a heavy weight, say 7 lb., and at the same point fix 6 feet of thin string; hang up the rod to the picture rail, letting the needle rest against a smooth plate of glass fixed to the wall with drawing pins; the rod will oscillate with a certain "period", which period can be increased by putting pieces of wood between the glass and the wall; when the point of the needle comes exactly under the picture suspension, the whole gear becomes unstable. Try and get a steady oscillation of twenty seconds, and you will then have a seismograph which will swing with a strong earthquake.

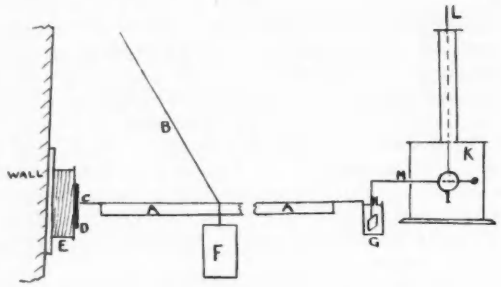


FIG. 2.

Figure 2 represents a rather more complicated kind of "boom" as Milne called his rod; this can be made by anyone with a fair mechanical ability, and full particulars have been published by the author*; a few copies remain at the service of any enthusiast. Suffice it now to say that F in the figure is a heavy weight of 56 lb.; the plate of contact is of agate; at the distal end of the boom is a magnifier; by means of an oil cup and blade, the boom is coupled to a hanging mirror, labelled I in the diagram. A slit light from an electric bulb shines on the mirror, which is focused and reflects the light as a point on to photographic paper. In many instruments the magnifier takes the form of a coil of wire moving with the boom in a magnetic field; the induced currents operate a mirror galvanometer.

Whether a magnifier is used or not, as in the old carbon writing, and whatever form of increase is used, it is always necessary that the photo paper should move. So it is wound on some kind of moving drum and unfortunately these drums are expensive. Kew uses a drum which rotates once an hour, at the same time traverses sideways so that a continuous spiral trace results and a speed of 30 mm. per minute is used. Interesting results may be obtained if the paper is wound on an ordinary barograph drum, but a speed of at least 6 mm. per minute is essential if any idea of distance is to be obtained. Earthquakes have a "period" of oscillation of from two to thirty seconds and these will be jumbled up unless some speed is used. Vibration produced by explosions, bombs, gunfire, have very rapid vibrations of less than a second, and to record these very high-speed paper has to be used—sometimes a yard a minute. This explains why a seismograph tuned for distant earthquakes does not respond to gunfire or traffic. Near quakes also require high speed.

You will have noticed that in the experiment with the suspended cane, the oscillations took a long time to die down and if no means are taken to stop these, the boom would continue swinging after the earth impulses had ceased; so some damper is used. With a weight of 56 lbs., oil damping is best but lighter instruments use a copper plate attached to the boom which moves in a magnetic field.

Another form of seismograph is represented in figure 3. This is an extremely simple piece of apparatus and will record quakes, but is not so satisfactory as a heavy boom. It consists of a weight suspended by very fine wire in a special manner, called the Zollner suspension, from a pillar set on levelling screws; this type of seismograph can be made with weights of a few ounces down to a few grains; the suspending wire must be correspondingly fine; the smallest instruments give very high magnification but the difficulty of tuning increases inversely as the weight.

Seismographs are delicate instruments and are subject to alterations in temperature, to air currents, to wind rocking trees nearby, and to even the presence of a human being. My own chamber is well under the earth, as is that of Kew. Seismographs especially those with long tuning are susceptible to the weight of water in the land, or the effect of tides; I am half-a-mile away from the Solent, but if oil coupling were not used the tides would show regular curves on the record. Milne was fond of exhibiting the sensitivity of his instruments; at one time he used a lamp-post set in concrete for his suspension and showed visitors that this could be moved by a cotton thread; at another time he was called up three times in one night because a spider spun a web to his boom and rang a bell attached to it.

Now a word about movements of the earth not directly caused by earthquakes. Tiny movements called microseisms occur through the year, but in summer are of short period and small, when they then cause little interference; but in winter, especially when the station is situated on recent geological formations, as is the Isle of Wight, the periods conforming with that of the seismograph, they are often so large that the more delicate movements of a quake are masked; in other words they may be described as a confounded nuisance. Apart from regular microseisms, these small movements with a period of seven seconds occur during cyclonic disturbances and the more concentrated study of them may form an addition to meteorological science.

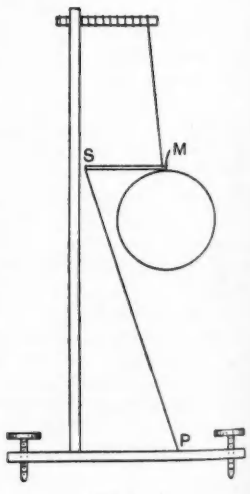


FIG. 3.

Seismographs are erected to record movements East and West,

* *Earthquakes for the Practical Amateur.* A few copies are available from the author, E. W. Pollard, B.Sc., The Quarry, Binstead, I.O.W.

North and South and Vertical. Vertical instruments are very difficult for an amateur to make. Each instrument is more sensitive in one direction. My large boom records East-West better, and indeed a quake from the Andes is usually much clearer than one from New Zealand, apart from the differences of distance. Seismographs are also greatly altered in appearance by the amount of damping. The first quake I ever received was with an undamped boom, and I was delighted that the oscillations went far beyond a four-inch wide paper; but I soon learned that to receive the finer movements of the early waves was of more importance than a showy record of the surface waves only.

Lastly, let us turn to figure 4, which is a reproduction, half size, of a pen-and-ink sketch of three recent quakes; the photographic record had of course many parallel lines of trace. To understand these one must first know that the speed of registration was 6 mm. a minute, which in the diagram will be 3 mm. P marks the reception of the first series of waves; the distance from P to S, which are the Secondary waves, is 13 mm.; this is little over four minutes; now travel times of all the waves have been worked out and the time between the arrival of P waves and S waves corresponds to about 1800 miles. In the middle record the distance between P and S is nearly 30 mm. and this corresponds to a distance of 5400 miles; and the quake was in Guatemala. And so on. The last record is a quake from the Balkans. This is the matter put simply, but as a matter of fact, other waves have to be considered and more calculations made. And let it be noted that only distance is found, not direction. As one gets accustomed to one instrument, one may often sense the direction; the best observatories have other means of finding out, but still the records of three stations are necessary for accurate placing of the Epicenter.

Readers wishing further information are advised to consult *Earthquakes* by Milne, revised and brought up to date by Dr. Lee.

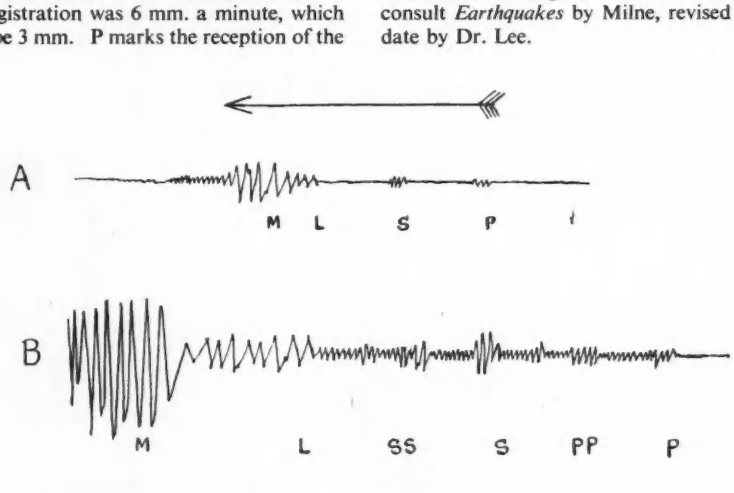


FIG. 4.

A Modern Jules Verne

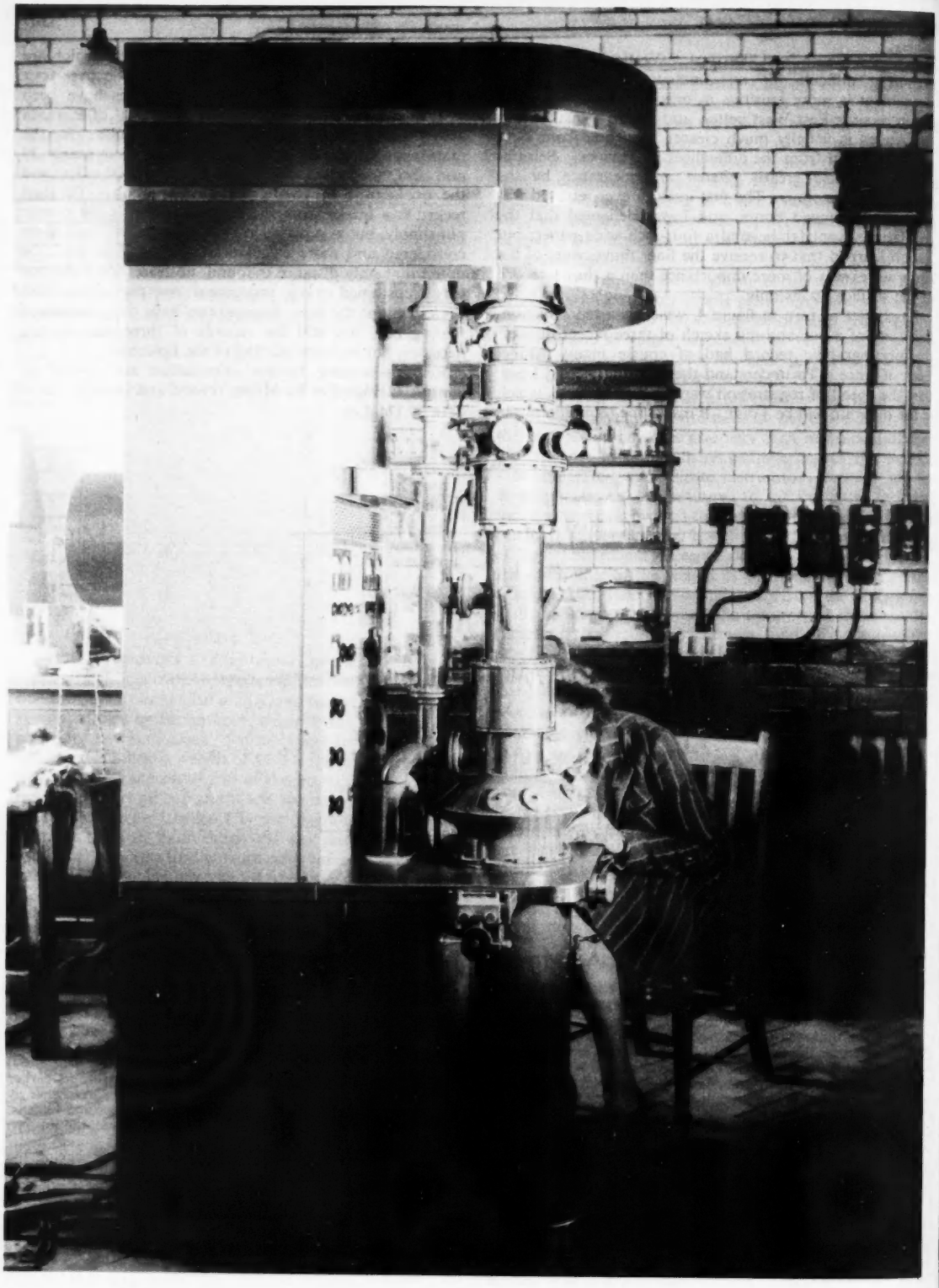
AN interesting airgraph from Mr. Felix Lachman, who in happier days, was selling agent for Warsaw for scientific instruments, has been sent to us. In February, 1941 (he writes), after many unhoped-for journeys in Eastern Europe, I found myself, cast by the tempest of fate, in a mysterious locality. I was there together with several hundreds of fellow-countrymen.

On the 21st day of March, 1941, I made a small hole in the soft wood of the lid of a small box (first-aid kit), and placed therein vertically a wooden rod, some 4 inches long. The sun was shining brilliantly. Just before noon I placed the box horizontally, by means of a thread-pebble plummet, and noted from time to time the position of the end of the rod's shadow. The shadow wandered on the lid, first decreasing, then increasing. I made on a narrow paper strip a 100 mm. scale, its length being equal to that of the rod. The length of the shortest shadow was 179 mm. Next, I calculated the length of the hypotenuse of the rectangular triangle, formed by the rod and its shadow: 205 mm. The rod-hypotenuse length ratio, i.e. the sine of the sun elevation angle was 100 : 205 = 0.488. Since sin 30° = 0.5, that angle was less than 30°. By additional calculations I succeeded in obtaining a more exact value of 29°15′. Hence, the Northern Latitude of *my* 'mysterious island' was 90° minus 29°15′ = 60°45′.

And now for the longitude. At the local solar noon (the time of the shortest shadow) the clocks in the vicinity showed about 1 p.m. I was told that the official time was two hours earlier than Moscow time, which, in turn, preceded Greenwich by 3 hours. Hence, Greenwich lagged behind us by some 4 hours. One hour corresponding to 15 degrees of longitude, the Eastern Longitude of my 'Island' was approx. 60°.

During six months I had no opportunity of checking the results of my crude measurements. However, on the basis of the determined latitude, I calculated the duration of the longest day, of dusk and dawn, and other interesting things.

When the 'shipwrecked' had been rescued by the ship *Freedom*, I at once went to the Captain's cabin, and found in the maps the true geographic data of my 'island': 60 40′ Northern Latitude; 60 30′ Eastern Longitude.



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The Electron Microscope

V. E. COSSLETT, Ph.D., F.Inst.P.

THE story of the development of the electron microscope is one of the most fascinating in modern science. In many respects it parallels that of the cyclotron, reflecting the tendency towards fusion of science and technology—advances in pure science leading to the design of complicated instruments which may then be used for further research in both pure and applied fields of work. Like the cyclotron, the main stages of development were also carried out by a small team in one laboratory in the space of a few years, and were not a matter of gradual progress over decades as with the modern radio valve and X-ray tube. The power of planned research in contrast to unorganised investigation could not better be exemplified.

The original work was carried out in the Berlin Technical College between 1930 and 1937, but not without some interruption as a consequence of Hitler's seizure of power in 1933. It was then developed mainly by the same team in the Siemens' laboratories into a marketable precision instrument and, but for the outbreak of war, we should doubtless have been importing them into this country, where an attempt at development had made very little headway. The only other independent work had been going on in Liége, where Marton had been working on the examination of biological material since 1934, and in Toronto, where two courageous research students had built from scratch a complete microscope, with no more than ordinary laboratory resources. But for these workers, and the initiative of the Radio Corporation of America, we might have had to wait until several years after the war before such a valuable research tool became available in this country. RCA took the bold step of engaging Marton from Belgium and Hillier from Toronto and turning over a first-class research team in electronics to help them, under the direction of V. K. Zworykin, well-known for his pioneering work in television. Within a year an improved electron microscope had been produced, and the following year (1941) it was on the market as a self-contained research unit. Under Lease-Lend arrangements there are now six of them in this country, some of them engaged on work of national importance in the war effort. Remarkable results have been achieved, and the work continues in the hope of ultimately making visible the disposition of individual atoms in the molecule—a prospect almost in sight of attainment.

The principle of the instrument and its advantages over the ordinary microscope can be understood by comparison with optical methods. Put simply: the electron microscope handles beams of electrons in the same way as the optical instrument does light. In place of glass lenses, magnetic fields are used to focus the beams and to project an enlarged image of a transparent object. The detail in the object is made visible by variations in the scattering and absorption of the incident beam of electrons. From different parts of the specimen different densities of beam are thus passed into the objective "lens", and these give rise after two-stage magnification to varying illumination on a fluorescent screen or photographic plate as the case may be.

Figure 2 shows the schematic lay-out of the apparatus. The main body is of metal, about six feet in height, and is earthed. The high voltage needed to produce a fast electron beam is applied by connecting the cathode C to the negative lead of a high-tension unit, the other side of which is earthed. This unit has to be designed to give a constancy of output of the order of 1 volt in 10,000. In the RCA instrument the problem has been solved by brilliant use of radio technique: the main supply is an oscillatory current of 32 kilocycles, controlled by feeding-back to the amplifier a fraction of the output, and applied to a resonant circuit of high selectivity instead of to a transformer; the output is full-wave rectified by valves, which are heated by alternating currents at different radio frequencies. This highly complex system functions with only two or three external controls.

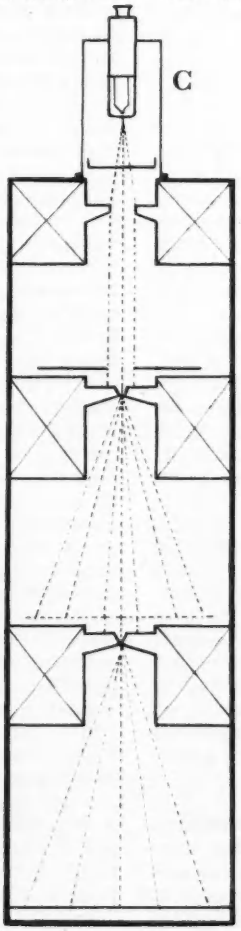


FIG. 2.—Schematic layout of apparatus.

The cathode, originally of the cold type, is now made in the form of a filament of tungsten wire presenting a sharp V-point to an opening in the surrounding shield; great progress has been made in the design of this type for use at high voltages. The cathode is insulated from the main body by a glass or porcelain discharge-tube fitted with fine-motion controls for centring it accurately on the axis of the main body. The first lens L_1 is a condensing lens for concentrating the electron beam on to the object situated in the plane O, which in practice is much nearer to the aperture of the objective lens L_2 than can be clearly shown in a diagram. The beam is focused by L_2 and forms an intermediate image in the plane I_1, where it may be viewed on a movable screen. When this is lifted, the beam forming the central part of the image passes into the projecting lens L_3 which throws the final image, further enlarged, onto a fluorescent screen in the plane I_2. The minute current in the image-forming beam is still sufficient to give a clear picture on the screen, which is then focused by fine control of the exciting current

← FIG. 1.—The R.C.A. Electron Microscope. (Photographs by courtesy of the Radio Corporation of America.)

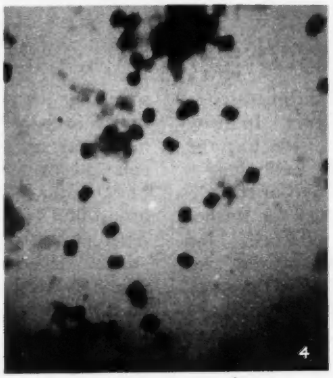


FIG. 3.—Bacteria B. Fluorescens. Some internal structure visible (× 6,000). FIG. 4.—Vaccinia. The small oblong bodies are the active agent which produced immunity from smallpox (× 10,000). FIG. 5.—Diatom. Nitzschia sigma. Note the structure revealed within each hole (× 14,000).

flowing in the coils of the magnetic lenses; the screen can be lifted to expose a plate beneath it, the normal exposure time being one second or less.

Magnifications

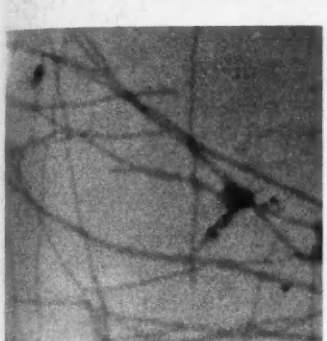
The "lenses" consist of windings of many turns of fine wire encased in a soft iron shield, to strengthen the magnetic field, terminating in projecting pole-pieces which are visible in the diagram. Across the small gap thus remaining an intense field is set up, in which the electrons are at the same time bent inwards and rotated. An image is then formed of any object "illuminated" by the electron beam at a distance given by the simple law for optical lenses, but rotated about the axis by a certain angle. For high magnification a short focal-length is needed and a correspondingly strong field; focal-lengths of 1 mm. have been reached with fields approaching 10,000 gauss. The working value in the commercial instrument lies between 2 and 5 mm., giving a magnification of up to 200 in each stage or a maximum over-all magnification of 40,000. In practice a value of between 10,000 and 20,000 is more usual, as compared with a useful limit of 1,000 in the optical microscope.

Under such conditions the whole path of the beam has to be shielded from the disturbing effect of external magnetic fields and at the same time has to be entirely in vacuum, owing to the rapid dissipation of the beam that would occur in air. The apparatus is continuously evacuated by high speed pumps, and specially devised taps of large bore enable the object to be changed, or moved about in the beam, without breaking the vacuum; through a special cassette at the base of the body photographic plates can be moved along to take several exposures and finally withdrawn.

The vacuum conditions impose severe restrictions on the range of specimens that can be examined, making it impossible to deal with living matter with its high moisture content. Further, owing to the ease with which electrons are absorbed the specimens must be extremely thin: normally not more than two-millionths of an inch in thickness, and hence very much thinner than the finest sections used in ordinary microscopy. Objects have to be specially prepared and mounted on cellulose acetate film of molecular thinness and carefully dried; for some purposes they may be carried on aluminium oxide webs as an alternative. Nevertheless a great deal of information can be obtained about the structure of bacteria, viruses, and even of large molecules such as haemocyanin, as well as of fine particles of colloids, clays, smokes and war gases.

To appreciate the additional range available to this instrument as compared with its optical counterpart it will be necessary to say a few words about resolving-power. In simple terms, this is the smallest angular separation of two objects that are still just appreciated as individuals by the observer. The unaided eye can be tested by moving away from a piece of wire-gauze, set up before a window, until the individual strands are no longer distinguished; the separation of two strands divided by the distance of the eye from them then gives the resolving-power of the eye in radian measure, which is readily reduced to degree measure. For the ordinary eye this is about one minute of angle, equivalent to a separation of 0·1 mm. at the distance of distinct vision 25 cm., or the space between the dots of a printed colon (:) seen at about 7 feet distance. The limit is set on the one hand by the wave-length of light and on the other by the fine structure of the human retina. The same principles apply to the optical microscope, and it can be shown that the limit is about 25 millionths of a centimetre when visible light is used and the aperture, or light-gathering opening, is of maximum size. A magnification of 1000 in the microscope is then enough to enlarge this separation of object-points up to 0·25 mm., which is easily visible to the unaided eye. Efforts to achieve higher magnification would thus be futile, and result only in enlarging the blurs in the image without clarifying them further. Using ultra-violet light, quartz lenses and photographic recording the limit can indeed be halved, but this is the best that optical methods can do, and it leaves unseen most viruses, the detailed structure of bacteria and of molecules—indeed all those things in the fascinating borderland between living and inanimate matter.

The idea that electrons possessed wave-characteristics



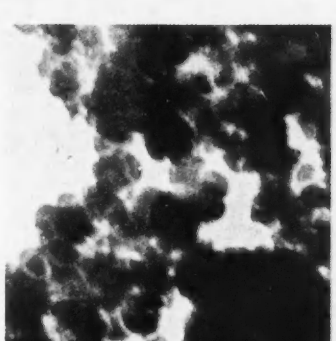


FIG. 6.—Aucuba Mosaic Virus. The virus responsible for disease in tomato plants (× 30,000). FIG. 7.—Tobacco Mosaic Virus (× 45,000). FIG. 8.—Carbon black (× 72,000).

gave grounds for supposing that they might be used in a similar way and give high resolution. On de Broglie's theory an electron accelerated with 60,000 volts would have an equivalent wavelength of one-half a thousand-millionth of a centimetre or about one-hundredth the size of an atom. Even with a very small aperture, therefore, the resolving-power would be much less than with light, and it was on this theoretical basis that the construction of the electron microscope was founded. In fact apertures of about 1/1000 only are in use, owing to the difficulty of overcoming spherical aberration with larger sizes; this would give a resolution of about 5 millionths of a millimetre. Several instruments have reached and slightly exceeded this figure; von Ardenne, working in his own laboratory in Berlin, claims to have reduced it to half. The commercial RCA instrument is rated at double the above figure, or 100 Angstrom units, which is 25 times smaller than the best resolution obtainable with visible light. A wide field of investigation of micro-structure is thus opened up.

The RCA team were busy up to the outbreak of war with Japan in an effort to increase the effective aperture of the lenses, and had made notable improvements. They also had experimented with working voltages of 300,000 volts, which would allow of the examination of thicker specimens. One of them has recently discussed the practicability of viewing atoms, and concludes that with the present technique the possibility exists for elements of atomic number greater than 25. Further progress would have to wait upon the discovery of means of correcting spherical aberration, allowing the use of larger apertures.

The other major task before us is to devise some alternative arrangement which, whilst utilising the minute wavelength of the electron, will enable the specimen to be placed in air and not *in vacuo*. Details of living processes, such as the division of cells, would then be open to investigation. One or two attempts have been made in this direction but with little result; again the war interrupted progress. By using a species of bacteria (*Bacillus vulgatus*) that survives repeated drying and moderate heating, von Ardenne claims to have obtained photographs of cell-division; the interpretation is doubtful however, owing to the procedure of return to the nutrient solution and re-drying of the specimen between photographs.

The Microscope at Work

At present investigations are mainly concerned with particle-size of inanimate materials and the micro-structure of viruses and bacteria in the dried state, and much valuable work has already been done. In particular, direct confirmation has been obtained of the dimensions of virus particles as originally given by X-ray examination. Observations have been made on the breaking down and dissolution of bacteria by other viruses (bacteriophages); the combination of bacterial antibodies with the flagellae and bodies of bacteria has been photographed. Details of many bacilli have been observed, including those causing typhoid, whooping-cough, and anthrax, and some which were too minute for optical examination have been photographed for the first time. Among the latter the most important is the influenza virus, visible as a small dot with a magnification of 65,000 and therefore only about 150 Angstrom units (or 30 atoms) across. Another application has been to carry the drying of the specimen to the point of destruction of the tissues (micro-incineration), leaving the metallic salts *in situ* as a fine ash. In the electron microscope it is then possible to distinguish the various components—sodium, potassium, magnesium, calcium, as the case may be—and obtain valuable information on cellular structure and constitution. By taking cells at different stages of development it is possible to follow the changes that occur in the location of the metallic salts during cell-division.

All this work is only in its early stages and offers great prospects so soon as conditions permit of intensive investigation. It is indeed ironic that, just when science was perfecting new means of exploring the border-land between living and non-living matter, where the nature of living processes may begin to find solution, we should be plunged into a life and death struggle for civilisation itself. The winning of the world struggle will open the way to the fulfilment of this scientific goal.

Some British Fungi

PHOTOGRAPHS BY W. H. SPREADBURY

1. — Geaster triplex, an Earthstar sometimes abundant in beech woods : often reaches 6 ins. in diameter.
2. — Cordyceps militaris, a parasite of insects. The Chinese consider an allied species, C. sinensis, to have medicinal properties.
3. — Armillaria mellea, the Honey Fungus, a most destructive parasite of trees ; sometimes eaten in Russia.
4. — Crucibulum vulgare, 'Bird's-nest'. The 'eggs' in the 'nest' are tiny disc-shaped packets of spores. There are three common species.
5. — Leocarpus, a common slime fungus. The transition from the slime stage to the fruiting stage is shown.
6. — Peziza cupularis, one of the Fairy Cups — a Discomycete.
7. — Nearly all these photographs show the fruiting or spore-bearing stage of various fungi. This photograph shows the mycelium from which the fruiting body develops.
8. — Morchella esculenta, the Morel. An edible fungus used for flavouring soups.
9. — Amanita muscaria, the Fly Agaric. Probably the best known and most striking of common toadstools. Deep scarlet in colour, with white spots which easily rub off.

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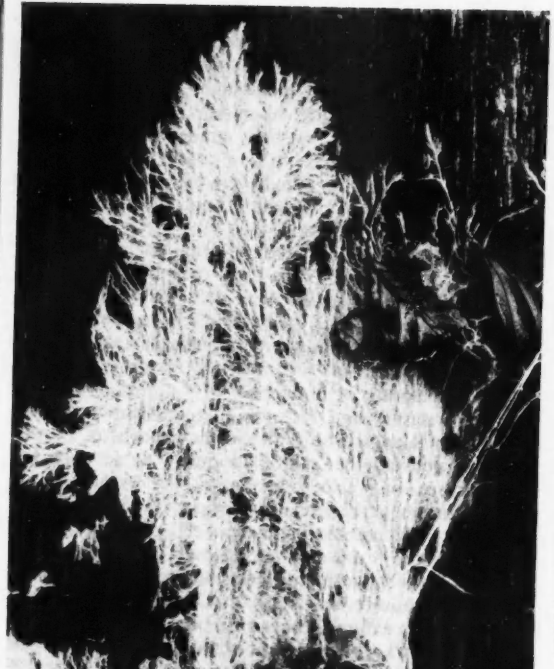

Progress of Chemical Research in China

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ALTHOUGH China has had an alchemy of her own since ancient times, modern chemical science was introduced from Europe about 1865. For half a century after that date, little real progress was made in the realm of chemistry in China owing to foreign aggression and unsatisfactory political conditions at home. Beginning from about 1920, however, research papers in the field of chemistry started to emerge from China, particularly from the Peking Union Medical College at Peiping (then called Peking) supported by Rockefeller Foundation funds. A new era came when the National Government was established in Nanking under the Kuomintang rule in Nanking. With the gradual cessation of civil wars and encouragement of scientific research under this government, both science and technology made big strides during the decade following 1927. Scientific societies were founded, research institutions were established and research was organized in various universities and technical colleges, which then began to spend a large portion of their budgets in buying books, journals and scientific equipment. Among all sciences, chemistry was one of those which made the biggest progress.

The year 1932 will always be an important date for Chinese chemists, because it was in that year that the Chinese Chemical Society was founded. The *Journal of the Chinese Chemical Society*, published by the Society, was started in the following year and is continued at the present in spite of the war. This journal, which is published in the Western languages (by far the greater portion of articles being in English), gives its space to original articles only. Another journal called *Chemistry* (China), issued in Chinese, was started by the Society in 1934. It publishes review articles as well as original contributions and some abstracts. *The Journal of Chemical Engineering* (China), published by the Chinese Institute of Chemical Engineers, which also publishes almost exclusively research articles, appeared about the same time.

Chemical research was flourishing in China, and the better type of original article was being published at an accelerated rate, when the Sino-Japanese War broke out in 1937. The initial setback which China suffered from the enemy was a severe blow to scientific research, owing to the fact that the best equipped universities and research institutions were formerly situated at the seaboard. As far as chemistry is concerned, we have never been quite able to recover from that blow, although things are now progressing slowly in the hinterland.

Viewing the types of research work that have been carried out in China during the last 10 or 15 years, we might say that the interests of Chinese chemists are widely varied, scarcely a line being left untouched. A special number of *Chemistry* (China), which is now in the press, to be issued to celebrate the tenth anniversary of the Chinese Chemical Society, contains a series of authoritative articles (in Chinese of course) which give comprehensive reviews (together with complete literature references in some cases) of the research work done in China in various fields of the chemical science. To this readers must refer if they want to know all about the results that have been accomplished by the Chinese chemists. In the following paragraphs only some pieces of work are briefly referred to by way of illustration.

Chinese Chemical Industry

To arm China the aircraft industry is of primary importance. Up to the present the construction of aeroplanes is dependent on the use of light metals, alloys of aluminum and magnesium with other metals. Aluminum is commonly manufactured from bauxite. While China does possess some bauxite ores, they are poor in quality on account of the high silica content which makes them unsuitable as an economic source of aluminum. In order to supply this vitally important material, Chinese chemists looked to alunite, a mineral unusually abundant in China, the alum mountains in Chekiang and Anhwei Provinces being long famous in the world. Three institutions (namely, the Research Institute of Chemistry of Academia Sinica, the chemistry department of the National University of Peking, and the Huang-Hai Research Institute of Chemical Industries) spent considerable time on this problem. As a result of such work it was concluded that alunite may prove to be an important source of potassium and sulphur for China, besides supplying aluminum. Recently, however, a good deposit of high grade bauxite is said to have been discovered in Kweichow Province, while most of our famous alunite regions have been temporarily lost. Hence the alunite problem no longer requires immediate attention.

China is the world's leading producer of tungsten. Before the war started, China used to export large quantities of tungsten ore to the United States and buy back ferrotungsten and tool steel from the same country. This uneconomic system has been stopped since the war. Under the auspices of the Materials Testing Laboratory of the Directorate of Ordnance, Ministry of War, both metallic tungsten and ferrotungsten are now manufactured from Kiangsi wolframite in the suburbs of Chungking. Moreover, the same laboratory undertakes the manufacture of various special steels, especially the tungsten steels which are now being used for high-speed tool steel, magnetic steel and die steel. Ferrosilicon and other ferro-alloys are also manufactured and the manufacture of artificial graphite electrodes is in progress.

Active carbon for gas masks has received considerable attention from a number of institutions. In the laboratory at least, active carbon of good quality has been obtained. New methods of preparing mustard-gas (by Professor Heou-Feo Tseou of the National University of Chekiang), signal smokes, smoke mixture, preparation of nitro-starch, and the utilization of wood and ramie celluloses for the

manufacture of nitrocellulose are examples of some other work in the field of explosives and chemical warfare.

Pure organic research was carried out in a number of institutions, especially in the Ching-Hua University, the National Central University, the National University of Peking and the National University of Chekiang. Improved methods of preparation for a number of organic compounds were found, new compounds were synthesized and the mechanism and kinetics of reaction were investigated in certain cases. Starting from castor oil (which is very abundant in North China), Professor C. H. Kao of the Ching-Hua University prepared a number of higher aliphatic compounds from the heptyl series up. The Grignard reaction was studied in the Research Institute of Chemistry of the National Academy of Peiping. Professor Tsi-Yu Kao of the National Central University made a study of keto and cyclol tautomerism of diketones.

In the field of analytical chemistry, Professor T. P. Chao of the National Central University spent several years in testing out his proposed schemes of qualitative analysis, which include analysis of cations without using hydrogen sulphide and systematic detection of the common anions. Both the Yenching University and the National University of Peking did some work on improving the methods of organic quantitative (ultimate) analysis. Professor Peter Sah's work on the identification of various series of organic compounds by means of derivatives includes a large number of papers and has attracted the attention of organic analysis in general.

Investigation of the active constituents (especially alkaloids) of Chinese drugs forms an important branch of research. Such work has been carried out particularly in the Peking Union Medical College, the Henry Lester Institute of Medical Research in Shanghai, and the Pharmaceutical Research Institute of the National Academy of Peiping. Dr. T. Q. Chou's work in this connection is noteworthy.

The vitamin contents of Chinese foodstuffs have been extensively investigated. Dr. C. K. Chuang's work on the total synthesis of sex hormones and Professor Edith Ch's recent work on the synthesis of compounds related to vitamin K may be classed among the better types of biochemical research.

In the field of physical chemistry, both Professor T. C. Huang of the Ching-Hua University and Professor Henry S. Frank of the Ling-nan University in Canton have made valuable contributions in thermodynamics and Professor Cheng E. Sun of the National University of Peking on dipole moments and quantum mechanical calculations of chemical reactions. Professors F. H. Lee and Y. K. Tai recently reported on the entropy and heat of hydration of gaseous ions.

But for the war, China would have made great progress in chemical research in the last few years. However, we believe that an Allied victory is not far off, and we look forward to the days of post-war reconstruction when Chinese chemists will endeavour to do their share in enhancing the welfare of mankind.

Bird Migration between Britain and U.S.S.R.

In recent years the bird migration studies of Soviet naturalists who fix numbered aluminium identity rings to the legs of wild birds, and of English naturalists who make similar experiments, have traced the migration routes of many birds from Russia southwards and westwards, and many of these, chiefly wild duck, winter in the British Isles and western Europe. The most interesting result of these Russian bird migration experiments was a kittiwake gull found near Little Fogs Island, Newfoundland, bearing a leg ring of the Central Bureau of Bird-Ringing, Moscow, who had marked this gull on the island of Khasilov in the Barents Sea, some 200 miles within the Arctic Circle. A grey lag goose shot in the Cromarty Forth of Scotland the other winter bore a ring inscribed: Moskwa 23554 D 160 A.

The movements of wild duck between Russia and western Europe have been studied in great detail. A mullard drake was shot at Stanlow Point on the Mersey marshes which bore a ring marked Leningrad. Lesnov Institut. D. 10110. It had been ringed as a nestling at Lake Ilmen, near Novgorod, on 15th July, 1932. A Tufted Duck marked when wintering in South Wales was recovered in the nesting season at Archangel. A teal caught in Pembrokeshire, in winter, ringed and then released, was found the following year in Russia at Maslovo, Pskov, while a young teal ringed at the nest at Lake Ladoga in Russia was recovered in Tipperary, Ireland, whence it had migrated for the winter. The widgeon, one of the most colourful and "musical" of wild duck visiting this country in winter, also have a migration route from Russia. One caught and ringed in February at Leswalt, Wigtown, Scotland, was identified by its leg-ring number three months later at Leningrad, and another at Kalenin, while yet another widgeon caught and ringed by British naturalists at the Orielton duck decoy in Pembrokeshire in January was discovered on the Vashka river, north Russia, in May. The pintail, one of the loveliest of our marine ducks, has also been proved to migrate from north and central Russia (Omsk and Petchora river) to South Wales, probably travelling via Holland or Iceland, whence ringed birds have also been recovered. Adult shovellers ringed in Pembrokeshire were recovered on the Petchora river at Moscow in June in Leningrad province, in spring at Kalenin and in S.E. Russia (Samara). A widgeon marked in winter in the English Midlands at Tamworth was later found at the Caspian Sea. Adult widgeon ringed in winter in Pembrokeshire returned to nest in Central Russia at Sanezuk and to Archangel, while a winter visitor to Norfolk was traced to the river Neiva.

A very interesting journey was made by some téal duck, caught and ringed when adult birds at Abbotsbury, in southern England early in the war and recovered in Central Russia, the Ukraine, at Vigo lake, and the Karelian peninsula of Russian Finland, whence they had obviously returned to nest. An adult widgeon marked in Norfolk was found on the river Ob in western Siberia in the spring of 1939. A goosander, one of the handsome fish-eating or sawbill ducks that visit our reservoirs and large rivers in winter, marked in Surrey, was traced to Archangel.

Eric Hardy, F.Z.S.

Case-history of a Chemist

THIS is a typical account of the career to date of a boy who was lucky enough to win a science scholarship to Oxford some ten years ago.

At the age of sixteen, as soon as he had obtained his School Certificate, he started to specialise in chemistry, physics and mathematics. After two years preparation he passed the Higher Certificate examination and six months after that, in December, won his University Scholarship. This meant that he would go up to the University in the following October, after another two terms at school, and this is where the first big mistake was made. Instead of freeing him from the shackles of examination syllabuses and helping him to broaden his mind with a study of the wider implications and applications of his subject, instead of filling in serious gaps in his education by introducing him to economics, politics and philosophy, his teachers decided that he should rather, for the aggrandisement of his school, take the Higher Certificate examination again in the summer. This he duly accomplished with distinction in physics and chemistry and a scrape through in mathematics. (He was at that time suffering from the dangerous illusion that mathematics was a dull academic subject little likely to be of use to him in the future. He has since deeply regretted this illusion which as far as he can remember his mentors did little to dispel.)

And so at length he went to Oxford to study for the Honour School of Natural Science in Chemistry, in which he would be examined after three years. The only examinations to be passed before that final inquisitorial orgy were called "Prelims". The subjects he had to pass in were his old friends chemistry, physics and mathematics and the standard to be attained was somewhat below that of the Higher Certificate examination. He found no difficulty in going through the by now familiar motions and satisfied the examiners during his first term.

About this time came the second major blunder. Our hero, who was a rather naive and trusting fellow, allowed himself to gain the impression that his teachers knew best and after he had obtained honours in his final examinations and spent a post-graduate year doing some academic research he would be fitted for whatever career he then decided to follow. He could become a schoolmaster, he might be able to stay on at the University doing academic research work, he might enter Government service, or most likely, he would go into industry. (Not having studied politics and economics he did not include among the possibilities those which might present themselves in slump-time when he might consider himself lucky to be allowed to sell silk stockings or insurance.) Believing correctly that he would be least ill-paid in industry he, almost subconsciously, made this his choice and trusted that industry would make him its choice. Of what precisely he would do in industry he was uncertain, but he imagined some vague kind of research work in congenial surroundings. There was so much to enjoy in the liberty of University life and sufficient work to do for his finals to keep him occupied without much thought of the years to follow. His tutor and the demonstrators he came in contact with were satisfied with his work and progress, and as he did not seem likely to be an outstanding worker in the academic field and as, therefore, their professional interest in him and responsibility for him would end when he obtained a good honours degree and had obtained his first job somewhere or other, they were content.

And what was his work? He was making quite a thorough study of the fundamentals of his subject and acquiring a fair knowledge of up-to-date academic work in many specialised branches. He studied textbooks and standard works and consulted papers in the current journals of pure experimental and theoretical chemistry. He carried out the required programme of practical work. When the time came for him to take his finals he could adequately compare and contrast the properties of boron and carbon, he could describe the preparation of pyridine by several different methods, he could write a good essay on electron diffraction or on infra-red and Raman spectra and so on. In short he had a good knowledge of pure chemistry, inorganic and physical. His finals over, he stayed up for another year, carried out a small, moderately neat, unexciting piece of research, wrote a thesis and became a B.A. 2nd class honours, with a B.Sc. What is more he got himself a job in industry, with the aid of his University Appointments Bureau.

By the grace of God, and largely because he was a fairly pleasant, adaptable fellow he got on quite well in industry. But he had a lot of shocks and made some interesting discoveries.

He found in industry that in peace-time always and in war-time sometimes the chief motive for production was not service to the people but profit. This meant that there was often a division of interest between the technical and commercial sides of a firm, and it was what the commercial side decided that went. To mix a metaphor, the technical staff often found itself playing second fiddle on its own ground. These observations led him to discover his ignorance of the political and economic affairs of the day and in the course of making good this deficiency he discovered what philosophy was, the relationship between science and philosophy and the power of science in its widest application to transform the world by removing want and war. Science he found had a function outside the laboratory, a social function, and he learnt that unless it could exert this function the scope and future for science in the laboratory would be limited. This meant that his bread and butter might be limited. Some of his contemporaries found this out while they were still at the University, some, like himself, found it out soon afterwards, the rest have not found it out. None of them had been taught that as scientists they must recognise their special responsibility to society. Many of their teachers had not recognised it.

He made another rather uncomfortable discovery. He had been taught that his primary job as a chemist was to seek out chemical truth no matter how long and painstaking the journey might be and no matter how trivial was

the goal in view. In the laboratory he had enormous resources of power and materials to aid in his search. But in industry things were rather different; his job was still to seek out truth, but there was a time limit. If his flask in the laboratory needed more heat he put another bunsen underneath it, but in the factory he had to know exactly what heat he wanted, for no more could be afforded. He had to learn the vagaries of pumps and stills, mills and agitators. He found that the handling of solids, liquids and gases in great bulk brought new and vital problems to be solved; it was no good merely scaling up his successful laboratory experiments. He found that his colleagues were fallible and often quite unscientific and at first he was shocked. But he found also that while he tackled fundamental problems of production in the laboratory his fellow-workers were actually producing, often by rule of thumb methods. Industry had not been able to wait until the last "i" had been dotted and "t" crossed and it still could not wait, although it badly needed his help. So he learned some chemical engineering and extended his belief that theory and laboratory practice must be unified to make science, to a new belief that at another level science and factory production and experience must be unified, each aiding the other forward to new knowledge and a higher efficiency. In fact in the course of a few years he learned a lot and came to realise some of his limitations.

What is to be concluded from this case-history? Was it not right for our hero to learn the hard way; did he not learn his lessons more thoroughly? Perhaps, but perhaps not. Not all his contemporaries have learned them yet; perhaps he in some disillusionment still to come will fall by the wayside. Anyway this is what he thinks now.

He regrets that at school and the University he was such a slave to examination syllabuses planned so exclusively by and for the scholastic world. That world seems to him now to be narrow-minded and complacent. Most science specialists find their way into industry, the existence of which his schoolmasters and tutors seemed to take for granted. He does not regret the sound training he had into the fundamental theory and practice of his branch of science, but he does wish that some time could have been devoted to the philosophy of science and its social function on the one hand and to chemical engineering and the application of science in large-scale production on the other. This might have meant the sacrifice of some detail on the academic side, but he ventures to think that the sacrifice would have been well worth while even for the minority of students destined for teaching and for pure research. The answer to his complaints does not lie in the development of technological Universities to train for industry, but in the broadening and strengthening of present school and University science courses.

J. S.

Industrial Alcohol

RECENT research has opened great economic possibilities of industrial alcohol. It is a most interesting study and its manufacture is by no means difficult.

Cereals and potatoes, as is generally known, contain a large proportion of starch, and when any cereal is allowed to germinate it produces a fermentation called diastase, which transforms starch into sugar. The regulated germination of barley, wheat, oats or rye, is called "malting". The germination is stopped when a maximum of the diastase has formed, and the malt is washed with tepid water. The diastase now converts the starch into sugar and the liquid assumes the designation of "Wort". Yeast is added to the wort, and in a short time fermentation sets in. The liquid seethes and froths and much gas is evolved in the process. The yeast breaks down the sugar into alcohol, and this gas is called carbon dioxide.

When the fermentation has died down, the liquor is called "Wash". The sugar has been changed into alcohol, and to recover this the wash is distilled. For this to be effected, the wash is run into large boilers heated by furnaces. The vapours containing the alcohol are dispelled and conducted through long pipes which are cooled in tanks of running water. The vapours return to the liquid state and constitute the "distillate" which drops from the end of the cooled pipes. This distillate is a mixture of water together with some of the higher alcohols known as "fusel oil". This mixture is re-distilled using special condensing apparatus as a rectifying column, and pure alcohol is obtained.

As a fuel, it would seem that alcohol is superior to petrol. And it is unfortunate that more use is not made of it during this present war. Its thermal efficiency is about one and a half times that of petrol. While it may be argued that alcohol is impracticable as a fuel because existing motors for aeroplanes and army vehicles would have to be modified, and that it is more expensive than petrol, it can also be stated that a mixture of alcohol and petrol, containing, say, 20% or 25% alcohol could be used in existing motor engines. Such a mixture would be more satisfactory than plain petrol which is so scarce in these troublous times.

Apart from its employment as a fuel, industrial alcohol is used on a large scale in many chemical industries. For instance, explosives, artificial silk, soap, and photographic materials all require the use of alcohol in their manufacture.

Finally, the reaction of the industry on agriculture merits consideration. No less than 4,000 acres of potatoes would be required for an annual production of 660,000 gallons of alcohol. The industry provides a use for low-grade potatoes and corn, which are unsuitable for human consumption, while the spent wash—from which the alcohol has been removed—is a valuable cattle food.

This comparatively new industry should prove of inestimable value to this country not only now during the ravages of war but in the days of peace.

P. M. CURRAN.

The Night Sky in November

M. DAVIDSON D.Sc., F.R.A.S.

The Night Sky in November

The Moon.—Full moon occurs on November 12d. 01h. 36m., U.T., and new moon November 27d. 15h. 23m. The following conjunctions take place:

Nov.				
14d. 10h.	Mars in conjunction with the moon		Mars	5°N.
14d. 21h.	Saturn „	„	Saturn	2 N.
19d. 21h.	Jupiter „	„	Jupiter	0·7S.
23d. 18h.	Venus „	„	Venus	3 S.

Occultations.—The following occultations of stars brighter than magnitude 6 take place, the times referring to Greenwich:

					a	*b*
Nov.	2d. 17h. 36·8m.	115	B.Sgr	D	−1·4m.	−1·1m.
	2d. 18h. 23·0m.	121	B.Sgr	D	−0·5m.	+0·2m.
	15d. 01h. 51·4m.	57	Ori	R	−1·8m.	−1·6m.
	18d. 01h. 50·9m.	θ	Cnc	R	−1·3m.	−0·3m.

(D and R refer to disappearance and reappearance, respectively).

The Planets.—At the beginning of the month Mercury rises at 6h. 20m. and sets at 16h. 44m. The planet is in superior conjunction on Nov. 10. At the end of the month the times of rising and setting are 9h. and 16h. 13m. respectively. Venus, a morning star, rises at 2h. 40m. at the beginning of the month and attains her greatest westerly elongation on Nov. 16 when the time of rising is 2h. 53m. At the end of the month she rises at 3h. 15m. Mars is an evening star, and sets at 11h., 10h., and 8h. 41m. at the beginning, middle and end of the month, respectively. The planet is in the constellation of Taurus and has retrograde motion, an explanation of which was given in DISCOVERY for September. The distance of Mars from the earth decreases from 56 to 50 million miles during November. Jupiter, in the constellation of Leo, rises just before midnight at the beginning of the month, and at 23h. 08m. and 22h. 15m. at the middle and end of the month respectively. At the beginning of November Jupiter is 513 million miles from the earth and this distance decreases to 471 million miles at the end of the month. Saturn is an evening star and is in retrograde motion in the constellation of Taurus. The times of setting are 11h. 07m., 10h. 08m., and 9h. 05m. at the beginning, middle, and end of the month respectively. The ring presents a beautiful appearance even through a small telescope. The distance of the planet from the earth at the beginning of November is more than 776 million miles and this decreases by 24 million miles at the end of the month.

Times of rising and setting of the sun and moon are given below, the latitude of Greenwich being assumed:

Nov.	Sunrise	Sunset	Moonrise	Moonset
1	6h. 52m.	16h. 35m.	10h. 23m.	19h. 10m.
15	7h. 16m.	16h. 12m.	19h. 03m.	10h. 28m.
30	7h. 41m.	15h. 56m.	10h. 21m.	18h. 54m.

Many interesting objects can be seen with the aid of a small telescope. The leader of the conspicuous constellation of Auriga, Capella, which is about 50 light-years distant, is attended by a close companion, not visible in the telescope, the two bodies revolving around their common centre of gravity in 104 days. Capella has a diameter 12 times that of the sun, but its mass is only a little over 4 times the sun's mass, because its density is very low—0·002 that of water. The constellation of Taurus contains two interesting groups—the Pleiades and the Hyades. Although neither of these is sufficiently concentrated to make a good telescopic object, the large field obtained by binoculars will suffice to show their beauty. The leading star in Taurus, Aldebaran, has a diameter 47 times that of the sun and a mass 4 times the sun's mass, its density being so small that the star might almost be described as a gas-bubble. It has a minute attendant, magnitude 12, which Dawes was able to see with a $2\frac{3}{4}$ inch refractor, but it is doubtful if many observers can rival this, and a much larger aperture, say 4-inch, is necessary to see this companion. In the constellation of Aries there is the double star γ, the fainter companion being fifth magnitude, which is a very good object for a small telescope. The star λ, just visible to the naked eye, has a companion at a distance 37″ of magnitude 8, which can be seen with a small telescope. Even a good pocket telescope will divide this object. It can be readily found by drawing a line from γ to β (easily visible to the naked eye), and producing it nearly twice as far as the distance between these two stars. The line will pass close to λ.

The Leonid meteor shower, the debris of Tempel's comet, is due on Nov. 13–14, and if there are any meteors they can be seen in the early morning hours. For several years, however, this shower has been very feeble or practically non-existent, and obviously the debris is becoming less dense and encounters with the earth's atmosphere less frequently.

International Clearing House for Books and Abstracts

THE Association of Special Libraries and Information Bureaux held its eighteenth annual conference at the Royal Society, London, on September 18-19. The inaugural address was given by Mr. J. G. Crowther, science officer of the British Council, who spoke on the subject of "Information Services for the Scientist". Because of its importance in modern civilisation, science must be handled with knowledge and judgment; scientific information services must be created to serve as indexes of all scientific knowledge, and Britain must organise her libraries to this end, as at present they were inadequate and poorly staffed. There should be, as part of a world organisation, a British Commonwealth Information Service, and a cabinet committee should be set up to examine the idea. The implications of this theme were developed by other speakers and some account of work already being done was given to the conference.

The Bookshelf

The Realm of a Rain-Queen

A Study of the Pattern of Lovedu Society, by E. Jenson Krige and J. D. Krige, with a Foreword by the Rt. Hon. Field-Marshal J. C. Smuts, P.C., C.B. (The Oxford University Press for the International Institute of African Languages and Cultures, London. pp.xvi + 336 + 4 maps and 10 pls. £1 1s.)

The Lovedu, whose socio-religious organisation forms the subject-matter of this ethnographical study, are a Bantu-speaking people of the Drakensberg in the northern Transvaal. They are, in the words of the authors, "not numerous and, from a military point of view they are insignificant". Yet they have a great reputation not only among neighbouring tribes but also among peoples so far away as the Zulus. The explanation lies in the fame of their Queen, Mujaji, who was regarded even by the all powerful Zulus of the early Nineteenth Century as the greatest magician of the north. Their territory in consequence remained inviolate in the midst of tribal turmoil, when Zulu conquests caused intense disturbance among the South African native peoples.

While the union of the functions of magician and paramount ruler is of frequent occurrence and wide distribution among African tribes, as it is elsewhere among primitive peoples, the position and reputation of the Queen of the Lovedu are exceptional. They are based on the widely accepted belief in her powers as the greatest of all rain-making rulers. It is unnecessary to enlarge upon the importance of these powers among peoples living in climatic conditions such of those of Central and Southern Africa—peoples whose very existence hangs by a thread, if the rains should appear likely to fail.

According to tribal tradition, the Lovedu were an off-shoot from the great empire of Monomotapa of which the centre was the Zimbabwe area—the great stone monument country to the north in what is now Southern Rhodesia. When that empire broke up they migrated southward, reaching the Drakensberg about the beginning of the sixteenth century . . . For two hundred years their rulers or kings differed in no respect in their reputation for magical powers as rain-makers from the rulers of other tribes. At the beginning of the nineteenth century, when the fortunes of the people and their reputation among neighbouring tribes had been reduced to a low ebb, the then paramount ruler sought to remedy matters by transferring the rule to his daughter, ratifying the transfer and instituting succession in the female line by incest. The present queen, the central figure of the study under notice, is the third in the line of female succession, having followed Mujaji II, the offspring of the incestuous union mentioned above, in 1894.

Mr. and Mrs. Krige have made full use of exceptional opportunities of studying the position of the queen among her people and the implications of the institution of the Rain-queen as an integrating element in the pattern of Lovedu society. They show how every ramification of daily life, of social and economic relationship, and every detail of group and individual behaviour is dependent upon the principle that the tribal life and organisation must be constituted and conducted so as to promote the well-being of the queen, and the full exercise of her powers. She in like manner on her side must exercise these powers for the benefit of her people or those outside the tribe who consult her or seek her assistance. This "service" will attain its supreme expression when at term, like other primitive king-magicians, she will end her reign in accordance with the ritual and commit suicide.

In the comparatively short period of its existence the International Institute of African Languages and Cultures has sponsored a number of very valuable studies of the African peoples; but even among these this study of the Lovedu stands out as exceptional.

Beyond the Microscope, Kenneth M. Smith, F.R.S., Pelican Books, 9d.

To write a popular book on science in this country used, not so very long ago, to be regarded as a highly unscientific procedure. The fact that the director of the Plant Virus Research Station of Cambridge University has written a popular book on viruses is an interesting indication of the change of attitude towards the rest of the community that is taking place among scientists. More and more, scientists are beginning to realise that science will never win its proper place in the community until there is a general education leading to an understanding of the aims and results of science. It must be recognised that much of the progress which has so far been made is due to the remarkable amount of work which has been undertaken in recent years by the Association of Scientific Workers.

Dr. Smith has one great advantage in writing this book, namely the intrinsic fascination of his subject. The conception of organisms working unseen, and, up until recently, unseeable, to produce deadly diseases in both animals and plants cannot fail to stimulate interest and imagination. Dr. Smith has made the most of his advantage, and unfolds a tale which is as interesting as any detective novel. It has the merit too of giving us both sides of the picture—that is, it deals with the virus diseases of both animals and plants. It tells us not only about the viruses themselves, but also how they are carried and by what agents. One particularly fascinating chapter describes how viruses are studied in the laboratory: how they are isolated, measured, grown and rendered visible. The final chapter which discusses briefly the nature and origin of viruses makes a fitting conclusion to an excellently written and extremely interesting book.

G. H. Bourne.

Human Physiology, Kenneth Walker, Pelican Books, 9d.

One of the greatest difficulties which educators of the masses have to face when they attempt to spread knowledge of diet, or of health problems in general is the abysmal ignorance of the average person about his own body. There is little doubt that the proper way to remedy this is to teach more human physiology in the schools. A book such as that produced by Dr. Walker would be extremely useful in such a course, but it will prove even more useful to the adolescent or adult who wishes to obtain a rational idea of how the body works. Some idea of the scope of the book may be seen from a brief examination of the contents. There is a chapter on the cell and the way in which cells are modified to form tissues, which is excellent, but perhaps a little too brief. However, in such a small book it is obvious that it could only be extended at the expense of other important sections.

Then follows a chapter on the digestive system and one on food, which is rather too sketchy. Chapters dealing with the circulatory system, respiration, excretion, the muscles, the central nervous system, the special senses, hormones, and reproduction, include a surprising amount of interesting material. Indeed, it is the chief merit of the book that although it concentrates an incredible amount of information into a very few pages, it does not degenerate into a sort of intellectual pemmican, but is on the contrary very readable.

The chief faults are in fact due to the necessity for compression, but in general there has been no sacrifice of accuracy. Perhaps the only exception is the suggestion that the brain of the Lancelet can be described as "a spiral cord with knobs on." Actually the brain of this creature is a simple unmodified nerve tube, indistinguishable from the rest of the spinal cord.

In conclusion one can confidently recommend this book to anyone who wishes to understand how the complex systems of the body perform their various tasks.

G. H. Bourne.

Infantry Officer. A personal record. Anonymous. (Batsford, London, 1943; 6/-, 80 pages + 21 photographs.)

This slight volume describes the impressions of an infantry subaltern during the B.E.F. operation in France. It is, of course, a very subjective account, and it is written in a rather immature manner. Yet it is a faithful picture of unfolding modern warfare impinging itself upon the mind of a normal young man who had just passed through Sandhurst. For that reason it may interest some of this magazine's readers whose studies lie in psychology. Otherwise, no particular scientific appeal. P.V.D.

Far and Near

BBC'S Friday Science Talks

THE first of the twelve BBC Applied Physical Science Talks was given by Dr. Julian Huxley on Friday 1st October at 7.40. p.m. The subject was Science and the House, and Huxley's 20-minute talk contained many interesting features. The following week's talk on the Science of Building was an appropriate follow-up. Sir Edward Appleton, Secretary of the D.S.I.R. and Sir George Burt, made a brilliant combined operation upon a subject that surely needs more scientific treatment. Below are given details of the remaining 10 talks, so far as they are available at the time of going to press. The time is Friday from 7.40 to 8 p.m. on the Home Service.

15 Oct. *Plastics*, Sir Lawrence Bragg.
22 Oct. *Clothing and Fabrics*, J. G. Speakman.
29 Oct. *Explosives*, John Read.
5 Nov. *Sounding the Earth's Crust*, A. O. Rankine.
12 Nov. *Our Weather*, Sir Nelson Johnson.
19 Nov. *The Housewife and the Fisheries* Michael Graham.
26 Nov. *Saving Life at Sea*, Albert Parker and H. S. Humphreys.
3 Dec. *Scientific Ship Design*, J. L. P. Kemp.
10 Dec. *Tunnel Builders*, G. L. Groves.
17 Dec. *Science in National Life*, Speaker—not settled.

Synthetic Drugs and Malaria

ANTI-MALARIAL measures are of such consequence in the present war that they formed the subject of a symposium at the recent Detroit meeting of the American Chemical Society. L. T. Coggleshall of the School of Public Health, University of Michigan, described how in addition to quinine, atebrin and plasmoquin, the efficacy of thousands of drugs of the sulphonamide class is now being tested in chicks, canaries, ducks and monkeys infected with different species of malarial parasite. The routine procedure with birds is to incorporate the drug into the mash; the birds have been infected with sporozoites from the salivary glands of infected mosquitoes, in order to simulate the natural mode of infection in man, and the extent to which the drug depresses the death rate is taken as a measure of its effectiveness. With this procedure atebrin, quinine hydrochloride and plasmoquin exert a definite effect in dilutions of drug to mash of 1/64, 1/32 and less than 1/256 per cent. respectively.

At present in America there are least twelve laboratories carrying out investigations of this type, employing birds or rhesus monkeys as the hosts of the parasite and six different species of malarial germ. Because of the importance of the problem more compounds have been tested in the past two years in America than the combined total number of all tried in previous years. Somewhat surprisingly anti-malarial activity has been found with more than 5% of the compounds so far tested; this is encouraging as it increases the likelihood of discovering a true prophylactic or therapeutic agent which will eradicate and not merely permit the malarial infection to smoulder.

An account of the development and production of the synthetic anti-malarials atebrin and plasmoquin was given by Alfred E. Sherndal, a chemist engaged in this branch of the pharmaceutical industry. He said that the final step in the synthesis of atebrin and plasmoquin had been carried out in the United States for a period of about six years from intermediates imported from Germany (the drugs being, of course, proprietary articles that were perfected in the laboratories of the German firm of Bayer). The demands for atebrin in America during the years 1933-39 were completely met by an annual production of about 1,200 lb. or 5,000,000 tablets; demands for plasmoquin were so small as to be negligible. The amount of quinine used throughout the world for malaria therapy was estimated at some 2,000,000 lb. or with the usual dosages, sufficient to treat about 50,000,000 cases a year. The picture started to change in 1939, due first to the outbreak of war and later to the complete stoppage of quinine supplies by enemy action, and still later to the widening field of military activity and the dependence of so many nations on the United States for supplies of anti-malarials. By the December of last year the United States was making 800,000,000 tablets a year—enough to treat 53,000,000 cases of malaria, the equivalent of the total world supply of quinine before the war. In the last half-year, production had been increased 50%, and by the end of this year America would be making Atebrin at the rate of 7,000,000 tablets *a day*. Chemists, laboratories and a large group of manufacturers in the United States and Britain are now collaborating in order to meet these extraordinary demands.

Pasteurised Eggs?

IT is reported from America that experiments are being made with the heat treatment of new-laid eggs to see if it improves their keeping qualities by destroying bacteria without impairing food values. Experiments so far show that eggs can be heated to over 120°F. without the whites becoming cooked. This treatment kills the embryo, thus improving keeping quality.

Gas-ripening of Fruit

SUCCESSFUL large scale trials have been made in Russia in the use of butylene in stimulating the ripening of fruits such as apples, apricots, pears, plums and peaches. The method of treatment is to enclose the tree in a tent for two weeks; butylene is passed into the tent in concentrations of 1 part in 100,000 parts of air at temperatures of between 69°F. and 100°F. for one or two hours. The method is reminiscent of work done in Britain, America and South Africa prior to the war to develop the use of ethylene and acetylene to speed the ripening of such fruits as plums, lemons and tomatoes.

This phenomenon of gas-ripening can be simply demonstrated on a domestic scale with tomatoes. This fruit responds to treatment with ethylene, and a convenient source of this gas is provided by a ripening apple, ethylene being one of the gaseous products of the metabolic processes that accompany maturation of apples. If green tomatoes are enclosed together with ripening apples in a closed container it will be found that they become red right through some five to seven days before the same colour change occurs with a control group of green tomatoes kept in a confined space but without apples.

Penicillin by the Vinegar Process

THE speed of production of penicillin has been speeded up in America by a method analogous to the "rapid" vinegar process, according to Dr. C. E. Clifton of the Department of Bacteriology at Stanford University writing in *Science* of July 16. Although the investigations have not yet emerged from the laboratory stage, it is considered by the author that the results prove that penicillin can be produced rapidly and in large quantities in acetic acid generators. The large-scale production of penicillin is hampered by the necessity of (1) providing a surface area exposed to the air of approximately 500 sq. cm. per litre of culture medium and of (2) growing the organism, *Penicillium notatum*, for 5 to 8 days under such conditions. It occured to Dr. Clifton that the fungus might grow well and produce penicillin continuously in a constant flow of medium trickling over a column of wood shavings in a plant similar to that commonly used in the "quick" or "generator" process for the production of vinegar from wine or cider by the acetic acid bacteria. Experiments showed that this process gave yields of penicillin approaching those obtained with the fluid from ordinary cultures of the mould growing on the surface of Czapek-Dox medium containing 4% glucose and 0.1% yeast extract.

Nature of August 28 records the results of some interesting tests made by a Czech bacteriologist, Dr. J. Ungar of the Glaxo Laboratories Ltd., in which penicillin was used as a bacteriostatic agent in conjunction with sulphapyridine, the widely-administered "sulpha" drug. In these tests the sulphapyridine was used in such small quantities that it would have been unable by itself to have exerted any appreciable bacteriostatic effect, yet it was found to have a remarkable "synergistic" effect on the penicillin, the potency of which against a strain of disease-causing bacteria was more than doubled. The experiments were first done *in vitro*; afterwards mice were infected with a lethal dose of the bacteria and then

treated with penicillin and sulphapyridine together when the success of the *in vitro* tests was repeated. If these tests can be fully confirmed the discovery opens up the distinct possibility that the small quantities of penicillin now available for medical practice might be made to go a lot farther.

The Medical Research Council last month issued a statement which said that the Committee on Clinical Trials of Penicillin (which controls the distribution of penicillin for purposes of clinical research) had been instructed to employ the present limited supplies to gain new knowledge of the curative possibilities of the drug rather than merely to repeat the therapeutic successes of which it is already known to be capable. In addition to a quantity which the War Office has received for trial in wounds among the Army overseas, supplies of penicillin for research into the systematic treatment of selected infections have been allocated to four centres in this country; four others are receiving, or are about to receive, smaller supplies for the study of local treatment only. The policy of the therapeutic trials now proceeding is to treat conditions known to be susceptible only so far as is necessary to define the minimum effective dosage, the best method of administration, and any factors not yet studied on which success may depend, and to explore the possibilities of penicillin treatment in conditions hitherto unstudied from this point of view. Even with the fullest co-operation of the Ministry of Supply and of the manufacturing firms, continues the statement, the difficulties in making penicillin on a commercial scale are still so formidable that the present output in this country is scarcely sufficient for the work in the four main research centres, and is only a minute fraction of the quantity which would be required if all cases of even a few specified infections were to be afforded treatment. The statement concludes: *Production on a greatly increased scale is being urgently undertaken both here and in the United States, but in both countries the requirements of the fighting Services are likely to absorb most of the output for some time to come and to name a date when adequate supplies will be available for general use is at present impossible.*

Comment on the general practitioner's attitude towards penicillin, as well as on that of the lay press is expressed in a recent number of *The Chemical Age*, which remarked:

"In its early stages a new drug can be an embarrassment almost to the medical profession. That is happening with penicillin since the demands for it so far exceed the supplies. The newspapers have led the public to expect great things of this "wonder drug," and its potency as a bacteriostatic agent has not been exactly understated by the medical profession. Indeed, it seems to us that some doctors have been guilty of an error of judgment in telling their patients that some diseases—osteomyelitis, for instance—can be cured by penicillin, and *only* by penicillin, for such patients are led to believe that they are doomed unless they can obtain it. Doctors should take notice of the Medical Research Council's statement about penicillin supplies and act accordingly, by doing nothing to add to the number of those people who are now under the impression that unless they are treated with penicillin they are bound to die. Our colleagues of the lay Press, too, would be doing a public service if they chose their words very carefully and avoided raising false hopes and false fears when writing about penicillin."

Personal Notes

DR. W. E. ADAMS, of the University of Leeds, has been appointed professor of anatomy at the University of Atago, New Zealand, where he graduated in 1935.

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DR. EDWARD HINDLE, regius professor of zoology at Glasgow University since 1935, has been appointed to the new post created by the Zoological Society, that of Scientific Director. Now aged 57, he was elected to a Beit Memorial fellowship in 1910, and subsequently for five years he held a Senior Beit fellowship for research in Tropical Medicine. During the last war he served with the Signals in France and Palestine. In 1925 he went to Northern China as joint leader of the Kala Azar Commission of the Royal Society. He is an authority on parasitology, particularly of insect-transmitted infections. It is understood that the post of Scientific Director of the Zoological Society does not carry with it a seat on the society's council, a prerogative which the secretary holds.

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MR. A. W. LING, chief agricultural advisory officer, University of Bristol, has been appointed principal of Seale-Hayne Agricultural College, Newton Abbot.

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DR. ALÉS HRDLIČKA, one of the leading anthropologists, died in Washington on September 5th at the age of 74. A Czech by birth, his parents emigrated to America while he was yet a boy. Towards the end of the last century he was chosen to develop the newly created Department of Physical Anthropology of the National Museum at Washington, and there he built up an extraordinarily rich collection of scientific material, which led to the department becoming a leading research centre.

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The committee of the Privy Council for Agricultural Research has appointed LORD DE LA WARR to be chairman of the Agricultural Research Council, in succession to the late Sir Thomas Middleton. The committee has also appointed PROFESSOR I. DE BURGH DALY, F.R.S., to succeed Sir Joseph Barcroft as a member of the Council. Professor Daly has been professor of physiology at Edinburgh since 1933. During the last war he served in all three fighting services, being first a private in the R.A.M.C., transferring to the Royal Naval Air Service and then to the R.A.F. Medical Service.

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Professor L. SUSAN STEBBING, professor of philosophy, London University, died on September 11 at the age of 57.

DR. JOHN RAMSBOTTOM's lectures about useful and edible fungi, which have become an event of the year so far as public interest in the Natural History Museum is concerned, have been repeated this year, and will continue until the end of this month (October). These lectures are illustrated with coloured slides, and members of the public are invited to bring or send to the museum specimens for identification and advice. An exhibit in the entrance hall shows the fungi which are edible, poisonous, or more or less useless.

Interest in edible fungi seems to be increasing, and centres which can give advice on the subject are to be found scattered all over the country, in towns as widely separated as Norwich, Bristol, Cambridge, Darlington, Cardiff and Huddersfield. This increased interest is doubtless partly due to the war and also to the influx of refugees from countries where fungi of many varieties are regularly marketed each autumn.

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The death is reported of PROFESSOR JAMES M. MACFARLANE, of the University of Pennsylvania, at the age of 87. He was of Scottish birth, being born at Kirkcaldy in 1855 and taking a science degree at Edinburgh before going to America, where he became professor of botany in Philadelphia just 50 years ago.

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DR. F. J. W. WHIPPLE, superintendent of the Kew Observatory and assistant director of the Meteorological Office until his retirement in 1939, died on September 25th at the age of 67. In 1937 and 1938 he was president of the Royal Meteorological Society.

Geologists and Museums

GEOLOGICAL collections are to be found in practically every museum, and while the larger provincial institutions have expert geologists upon their staffs, and some of the smaller ones are fortunate in having curators who are well versed in that science, there are many where the one official, perhaps a zoologist or an archaeologist, is handicapped by lack of training from utilising appropriately the geological material in his care. For full use to be made of the right use of leisure, it is hoped that the services of experts may be secured. It is suggested that any Fellows of the Geological Society who may be in a position to aid a local museum should send their names to the Honorary Secretary of the Museums Association, Dr. M. B. Hodge, Bankfield Museum, Halifax, indicating the locality in which they are interested and the details of the service they would be able to render.

Hard Coke and Research on Coal

METALLURGICAL processes in industry have been largely developed around the use of coke, and modern developments in coke production have progressed far ahead of the old beehive oven. The manufacture of coke is at present dependent on the use of a relatively narrow range of coals; coal derived from some

seams is quite useless for the production of metallurgical coke, which needs to have special characteristics to make it suitable for use, as, for instance, in smelting furnaces. A good deal is already known about the suitability of coals for coking, but there are still influences at work the process mechanisms of which are not fully appreciated. Accordingly, research work on coal is itself most valuable to coke manufacturers. Last month the Research Committee of the British Hard Coke Association visited the laboratories of the British Coal Utilisation Research Association. Members discussed the special aspects of several investigations into the fundamental characteristics of coal, which affect its coking abilities, and saw the many techniques devised to throw new light on coal behaviour. One of the most interesting of these tests has now been developed to a point in which it is directly useful in the choosing and blending of coking coals, and several others which were shown to the visitors have been recently discussed at some length at the Royal Institution during a conference on the ultra-fine structure of coals and cokes.

New Chinese Science Journal

A NEWLY founded scientific journal *Science Record* has recently appeared in China, in spite of all her military trials. It is published by Academia Sinica, under the editorship of Professor Y. H. Woo. Nos. 1 and 2 of Vol. I contain 60 original articles distributed in ten branches of natural science, all written in Western languages, mostly in English.

This new periodical was published, as the foreword of this issue says, "in accordance with a resolution passed in 1941 by the National Research Council of Academia Sinica. The papers contained herein are brief accounts of original scientific work accomplished in China by the Chinese scientists. All fields of pure and applied science are to be included. The manuscripts for the present issue were all ready in the Spring of 1942; but printing difficulties during the war time prevented it from appearing earlier."

The contents of these two numbers contain 25 papers on Mathematics, 8 on Physics, 4 on Chemistry, 2 on Meteorology, 1 on Crystallography, 3 on Soil Science, 3 on Geology, 7 on General Biology, 6 on Botany, and 1 on Zoology.

Surgery and Land Mines

THE standard land-mine detector of the British Army has proved so sensitive that it has been used in emergencies to locate shrapnel in the human body.

Coal Conference in November

THE British Coal Utilisation Research Association is holding a Conference on Problems in the Utilisation of Small Coals, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, on November 10th and 11th, 1943. The Conference is being arranged to discuss the problems related to the more general utilisation of small coals with particular reference to the results obtained by users of these fuels.

Absenteeism among Women

FROM a report *A Study of Absenteeism among Women* (H.M.S.O., price 2d.), it would appear that very few women in the two factories analysed were in the habit of losing one or two shifts each week. Married women on the whole lost more time than single ones. More absences were from single shifts than from full weeks, the latter being due mainly to sickness. More women stayed away from work on Saturdays than any other day; there were fewer away on paydays than any other day. Younger women (up to 25) lost more time than older ones.

This report upon two factories suggests that in dealing with the larger survey, there is need to study personal causes for absenteeism, for an individual method of treatment, for examination of travelling distances, as were as to the general conditions of work.

Hook-Worm in China

AN article on the Hook-worm disease in *The Chinese Medical Journal*, 61A, No. 1, 1942, says that on account of extraordinarily favourable climatic conditions and certain agricultural practices hook-worm infection and disease have been found to be very widespread in Szechwan, one of the largest, richest, and most densely populated provinces of China, in which Chungking is situated.

In striking contrast to the situation in the sericulture centres in East China, investigated by Cort and others of the China Hook-worm Commission, no association between mulberry cultivation and hook-worm disease in the mulberry areas of this part of China has been found. In full agreement with the conclusion reached by the China Hook-worm Commission, Chinese epidemiological studies have proved that cultivation of rice in Szechwan produces conditions unfavourable for hook-worm transmission. The cultivation of sugar cane and citrus trees in the province also do not seem to be important sources of hook-worm disease, whilst general "dry land cultivation" of miscellaneous crops in the hilly sections of the province probably produces conditions rather favourable for hook-worm propagation.

A specific association of corn sweet-potato cultivation and hook-worm disease, previously unknown in China or elsewhere, has been discovered in Szechwan. The procedure of corn sweet-potato intercropping, it is stated, produces remarkably ideal conditions for the dissemination of hook-worm.

Salvaging Defective Castings with Plastics

TO-DAY wastage of metal castings due to excessive porosity is a serious obstacle to production and must be reduced to the minimum. An interesting process which enables porous castings to be salvaged has recently been developed, and depends on treating the castings with Bakelite solution under moderate pressure which ensures that all the pores are sealed. A controlled heat treatment causes the plastic to set and after cooling the castings can be passed to the testing department. It is found that the Bakelite resin within the pores of the metal is quite insoluble in water, petrol, oil, alcohol and other solvents, and resists steam even at high temperatures. After treatment, test pressures can often be applied to the castings and maintained up to 8000 lb. per square inch. The process is equally effective with ferrous and non-ferrous metals (including light alloys).

"R.D.X."

IT is now known that the Allied Nations are using a powerful explosive, called "R.D.X."—meaning Research Department formula "X."

The explosive is not new. In point of fact it was known in the early part of the century. The difficulty has been to make it on anything like a useful scale.

Many chemists and scientists of many nations tried to solve the problem of manufacturing this explosive, but none succeeded in finding a satisfactory method until the Research Department of the War Office achieved it just before the present war broke out.

Just over twenty years ago, the Research Department—now known as the Armament Research Department and incorporated in the Ministry of Supply—began their experiments, and after 16 years they got within measurable distance of success. The final process of filling a shell with the explosive was going forward when something went wrong. A group of men were watching the mixing through mirrors, from behind a blast wall. They saw what was happening and ran into the danger zone to stop the process.

Unfortunately, even as they moved forward there was a tremendous explosion which killed five of them. The names of those who died were: Commander P. A. M. Long, Mr. F. C. Lewis, Mr. S. Cooper, Mr. W. E. Johnston, Mr. J. Brignall. The progress that they had made was not lost, and as a result of their experiments, we are now able to produce in ever-growing quantities an explosive more powerful than T.N.T.

"R.D.X." is being made in Canada and the United States. In both countries, great strides in production have been made which enable the explosive to be produced more simply, and more cheaply, than anywhere else. All the United Nations will share the benefits of British experiments, Canadian and American development and production.

A British Council Medical Film

FIRST of a series of medical films made for the British Council for exhibition overseas to medical audiences had its premiere in London last month. Entitled "Surgery in Chest Disease", it was made by G.B. Instructional with the co-operation of the staff of the Brompton Hospital, and shows the scope and progress made in this field of surgery. Doctors will be interested in the sequence depicting an operation for the total removal of a lung affected with cancer, a difficult operation which was first attempted ten years ago.

Printed and published by Jarrold & Sons, Ltd., The Empire Press, Norwich

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HANDBOOK

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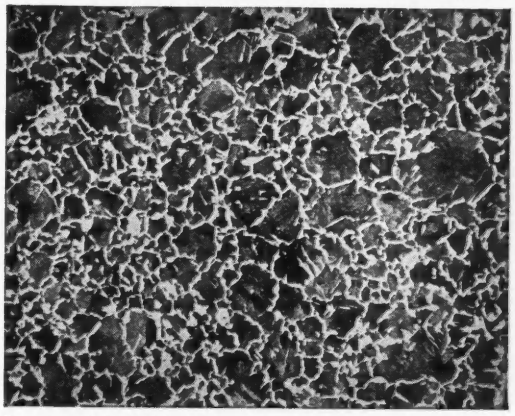

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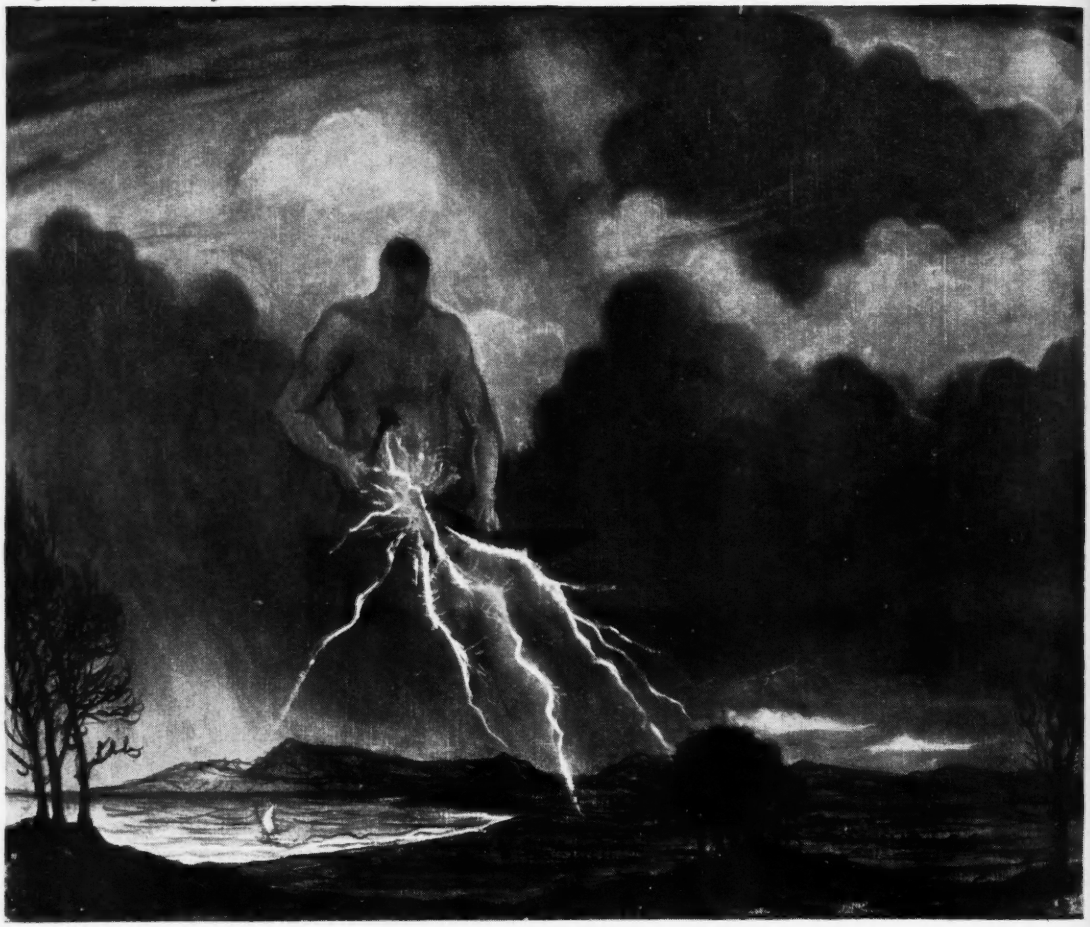

VULCAN'S FORGE

VULCAN, or Hephæstos as he was known to the Greeks, was no common blacksmith. He was a worker in metal, in the non-ferrous metals copper, brass and bronze, who built the thrones and decorated the shining palaces on Olympus. He was also the armourer of the Gods and forged the thunderbolts for his father Zeus. Today the non-ferrous metals are essentials in peace and war. The development of the manifold industries which are linked to electricity, the steam locomotive, the turbine or the internal combustion engine depend on non-ferrous metals in new forms and greater purity. The electrical industries with their extensive ramifications need huge supplies of the purest copper. Copper is also needed for locomotives, breweries, sugar refineries, calico printing and paint manufacturing —to name but a few. Not only is there need for more and purer metals, but for all kinds of alloys. The British chemist has helped the British aircraft industry to achieve its superiority in many ways, but not least by developing new and stronger alloys without which it would not be possible to build aircraft capable of flying across the world. Nor is the chemist satisfied merely to improve the metals known to Vulcan, or even to find special alloys to meet fresh needs. Without his aid, for example, nickel—"Old Nick's" metal—could not have been produced on the scale it is at present nor find uses in so wide a range of industries. Manganese, chromium, vanadium and tungsten, at one time metallurgical curiosities, are now used in a diversity of trades from stainless steel for cutlery to high speed tools for industrial production, and armour-plate for tanks, battleships and "tin-hats." Radium is man's ally in the fight against malignant disease. These are the achievements of the laboratory. Without the continuous assistance of the chemist and the chemical industry, the manufacturing processes which use non-ferrous metals would speedily fall behind in the race for efficiency, and mankind lose the valuable services which these metals can render.

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